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EDITORIAL NOTES.

"The Lancet's" Gas-Stove Investigation.

IN other columns to-day, we reproduce from the "Lancet" the results of the investigation that its laboratory staff has been making into the question of the hygienic efficiency of gas-fires. We welcome this absolutely independent research, though carried out under severely critical conditions (which make the results more valuable), as we believe this interest outside the gas industry will have a triple good effect—first of all, in increasing the satisfaction of the public; secondly, in causing the public (through medical men) to demand gas-fires that comply with the highest standard of hygienic efficiency; and, thirdly, in compelling, through the force of demand, the makers to discard all types of productions that do not comply with the standard, and to design all gas-fires so that they will satisfy the standard and test, which claim that products of combustion shall pass wholly through the flue-outlet, without the aid of elbow, flue-pipe, or chimney. The duplicate testings (which, it is patent, have been conducted by the "Lancet" staff without either fear or favour) confirm the claim that the best modern gas-fire structural practice has reached a stage of absolute hygienic efficiency, but that all makers cannot claim that the full range of their types of fires complies with the level desirable to ensure immunity from products escape into the room, without having to rely upon that uncertain human factor in the shape of the fitter, upon varied lengths of flue-pipes, and upon chimneys that may not render much assistance to the fires.

In order to disarm our captious critics (part of whose business in life appears to be, for trading reasons, to unfairly discredit gas-fires), it may be pointed out that the bulk of the fires tested by the "Lancet" staff were not of the types designed to pass the hygienic standard to which reference has been made, but were designed with a view to their use with flue-pipe and the action of a chimney draught. The tests applied were the "Shadowgraph" and the "Lancet" chemical test, the latter of which is of such a simple order that it can be used by any fitter for the testing of fires *in situ*; and this test, being very sensitive, ensures that any fire that by it does not disclose leakage of products of combustion under the canopy is perfectly controlling their travel. All the fires tested (whether specially designed to pass the severe hygienic standard, or designed for working efficiently hygienically when fitted with flue, and subject to the action of chimney) were placed in the middle of the laboratory—first of all, with no attachment to the flue-outlet; secondly, with an elbow only; thirdly, with 2 feet of flue-pipe; and, fourthly, with 4 feet of flue-pipe. The results in certain of the cases—some of the bad ones—would have been of a different order if the fires had been tested under the influence of a normal chimney. Therefore the results found with several of the fires can be ruled-out as having been obtained under circumstances with which the fires were never intended to comply. The "Lancet" investigators realize this, for they remark: "From the hygienic point of "view, it matters little whether a stove works in the open "without or with an auxiliary 'pull,' so long as, when it is "set in its place of practical duty, it shows no leakage of "combustion products. Although a fire may fail unattached "to ventilate itself automatically, it may work perfectly well "when it receives a chimney 'pull,' which may equal any-"thing from that of a 6-feet to a 16-feet flue-pipe." At the same time, the worst results found in the tests are of value in indicating how far removed the fires concerned are from the structural state that will comply with the critical standard which it is proved can be met without any depreciation of the radiant efficiency of the fires. The tendency of the gas industry is to work to the most stringent hygienic standard and test, so that, under any circumstances in which gas-fires are fitted, given a normal chimney—a chimney, say, that will pass all the products of a coal fire—there will be no need to rely upon a length of flue-pipe which it is not always possible to fix, nor upon the fitter's empirical and speculative judgment or absence of judgment as to what in the circumstances is requisite.

As to the results of the tests under the severe condition of no help from a chimney, four of the 28 fires tested gave no evidence of the escape of products of combustion when only the flue-nozzle was left to do the effluent work; seven fires did not allow products of combustion to escape when only an elbow was attached; and eight fires required only 2 feet length of flue-pipe. There we have nineteen of the fires accounted for out of the twenty-eight; and they are spread over the modern productions of most of the leading makers. These results show the perfect ability of four of the fires to comply with the stringent test, and how near the seven fires fitted with an elbow only have been brought to the structural state in which the conditions of the test would be complied with. We are well satisfied with the result. But there were five of the fires that did not show negative results until 4 feet of flue-pipe had been attached; and four showed a leakage even with 4 feet of flue-pipe attached. Some of these, however, are types of fires that have been withdrawn from sale by the makers (one was an old ball fuel fire); and even with them quite a different result would have been obtained under the influence of a normal chimney. The "Lancet" investigators suggest that all fires that require, under the conditions of the test, a length of flue-pipe exceeding 4 feet should not be accepted for service. For practical reasons, and considering the variable conditions under which gas-fires are fixed and used, we go farther than the "Lancet," and say that gas-fires requiring, when tested away from the influence of a chimney, a 4-feet length of flue-pipe to obtain negative results under the canopy, should not be purchased, seeing that gas-fires of equal heating value can be made by any manufacturer so disposed that will pass the stringent test of sending all products of combustion unaided out of the flue-vent with the fire standing in the centre of a room. The "Lancet" test has placed in the hands of gas undertakings a simple method of proving hygienic efficiency; and they will make use of it in and away from gas consumers' houses—and to the immediate and large ultimate advantage of the gas industry. The gas-fire season is practically over; and we strongly advise gas-fire makers to weed out from their stocks all patterns that require anything more than a 2 feet length of flue-pipe to give, when tested away from a chimney, negative results in the matter of products of combustion under the canopy, and to devote themselves, in preparation for next season, to the production of fires that will pass the more stringent standard of no escaping products without the aid of elbow, flue-pipe, or chimney.

In presenting the results of their tests, the "Lancet" investigators touch upon the question as to whether the condition of a perfect hygienic efficiency is repugnant to a high radiant heat efficiency. The "Lancet" investigators, on *a priori* considerations, entirely confirm the conclusions of Mr. W. J. Atkinson Butterfield and several of the gas-fire makers, that the highest standard of hygienic efficiency yet proposed can be complied with without affecting radiant efficiency. Let the "Lancet" investigators speak for themselves: "It should be remembered that we are dealing with "fires which are claimed to give chiefly radiant heat. The "effect of a 'pull' on actual radiations need not be serious. "Radiations from the sun obviously travel through cold "currents of air without much disturbance, and these heat "radiations can be focussed through an ice lens. On heat "currents the effect of a strong draught would be marked. "After all, the public may be trusted to decide whether a "gas-fire is an efficient warmer for the purpose; and a "stove would naturally soon be rejected if it failed in this "respect." This plain statement of fact does not require accentuation. Further advances in radiant efficiency may be expected, although not much in comparison with the advances already made. As the "Lancet" investigators fairly recognize, the makers of gas-fires have been devoting them-

selves to securing as much as possible of the calorific value of the coal gas in terms of radiant efficiency, while assisting ventilation as is the case with the coal fire. One more extract from the investigators' article: "The combustion of coal is "always imperfect, and therefore wasteful and offensive; "the combustion of gas is complete, and therefore econo- "mical and inoffensive. It is a manifest advance in domestic "methods of heating by gas that the modern gas-fire can "now provide a radiant efficiency of from 50 to 60 per cent. "We attach importance to this step from economic con- "siderations; but we attach far more importance to it when "we know that this position can be gained with hygienic "security."

We are well satisfied with the results of this independent and impartial investigation by the "Lancet" staff; and we are certain it will have the good effects referred to in the opening of this article. There are suggestions for improvement in fires where comparison has shown minor fault to exist—for instance, in connection with the shape and capacity of flue openings and flue-pipes. Slight escapes of products at the end of the canopies of some fires suggested to the investigators that the distal radiants should be removed. We do not think this is necessary. It is a question of the design of canopy, and nothing more; and appearance must be studied. We have not the slightest doubt that some of the makers of gas-fires will not be satisfied with the results of the tests, or the types of fires tested, to which their names are attached; but any who are so dissatisfied will note the offer of the investigators to put to test any other fires that such makers like to submit. Their object has not been to discredit any firm of makers, but to make known how far the makers have reached, or have got towards, perfect hygienic efficiency, without the intervention of such uncertainties as flue-pipe length, pull of chimneys, and the perfunctorily disposed fitter.

The Dublin Board and the Concealed Report.

It appears from what we hear that the extended report of the proceedings at the meeting of the Alliance and Dublin Consumers' Gas Company published by us last week, and the comments that served to show the need, in the present situation, of placing upon the Board a man technically and commercially qualified in modern gas affairs, have raised a large amount of interest not only among the many who are pecuniarily associated with the Company and who read the "Journal," but among a considerable number of gas men who are interested in the matter from the point of view that the gas affairs of the capital city of Ireland in more ways than one—for example, the price of gas, the market value of the Company's stock, and the reduction of the dividend to a very poor figure—are not what may be termed a credit to the industry's reputation. In all directions, save in the seclusion of the Board-room of the Company, and among the non-gas-professional proprietors of the Company, there is accord with our contention that the *desideratum* at the present time is a thoroughly sound expert on the Board.

This, however, is not the view of Mr. F. J. Dickens and his two Lancashire colleagues who have been placed on the directorate; and we may take it their view has the full sympathy of the old members of the Board, who are not anxious to have disclosed the report of the two investigating experts. In last week's comments, we criticized the singular attitude of Mr. Dickens in regard to the question of a gas-qualified Director; and we had hoped he would have further discussed the point. But having secured the election to the Board of himself and his colleagues, probably he prefers to refrain from getting into a controversy in which his own personal and successful experience as a cotton spinner would serve us as an excellent illustration that he is wrong. Moreover, he is a confessed layman in gas affairs; and we submit that he is not therefore a competent judge (as his words and action prove) of what is best in the composition of the administration of such complex technical work and business as gas manufacture and supply, with all their ramifications in connection with the secondary products. No one who has addressed us on the subject, or with whom we have come into contact, thinks that the Dublin situation in respect of the Board has been dealt with as happily as it might have been. Now that Mr. Dickens and his two Lancashire friends have secured election to the directorate—not one of them being either technically or commercially qualified in gas affairs—it is for them to justify their action by operations and results. If they are successful, we shall not hesitate to compliment them; if they fail, within reasonable time, to thoroughly set the Company's "house" in order, if they fail to save where savings can be effected, if they fail with the return of lower coal prices (supplemented by possible savings) to give the consumers gas at a lower price, and to restore to the proprietors of the Company a fair rate of dividend, then their failure will reflect upon their action prior to, and at, the recent meeting, in resisting the appointment of at least one technically and commercially qualified gas administrator.

The haste evinced at the meeting to consummate the plans of the Lancastrians did not suggest that the Committee were, in view of their strong proxied position, at all anxious to take other proprietors into their counsel before determining what was best for the Company. Had they been they would have willingly accepted and supported Mr. R. W. Edwards when he moved that six stockholders should be appointed to co-operate with the Lancashire Committee for the purpose of: (*a*) Investigating the position as to additional Directors; and (*b*) to consider the experts' report—subsequently reporting to the proprietors, and submitting recommendations. This would have been a far more reasonable line of action than the hasty one in regard to the new Directors, and the secretive one in regard to the experts' report, that were taken. Concerning the election of two of the new Directors, Mr. Edwards clearly gave sufficient ground for pause; notwithstanding that the new Chairman of the Board (Mr. John Murphy) stated that they had taken Counsel's opinion on the subject of the power to increase the number of Directors from six to eight. Mr. Edwards had also taken Counsel's opinion; and this was contrary to that of Counsel consulted by the Board. We have not the Company's Acts of Parliament before us. But as we understand the position, the Company's Act of Incorporation authorized the reduction of the number of Directors from nine; but we do not gather that the Act also gave power to retrace steps, once the reduction had been effected, and again raise the number to eight. For years the number of the members of the Board has stood at six. It was explained by the Chairman that the proprietors had not previously resolved on a reduction of the number of Directors; but if this was the case, wherein came the necessity for giving notice to the proprietors of a return to a greater number? If the proprietors had not previously resolved upon a reduction, there was nothing for them to resolve upon in the matter of reverting partially or wholly to the *status quo ante*. The fact that the number of the Directors had been standing at six was a substantial admission of reduction in accordance with the Act; and further the notice to increase the number was a tacit admission that the Directors felt, or were advised, that they could not again increase the number without the sanction of the proprietors. But even with the sanction of the proprietors, is this reversion to a greater number provided for in the Act of Parliament? If it is not, then what is the position of two of the new Directors in taking an active part in the administration as Directors of the Company's affairs? We certainly think the Board ought to take more satisfactory steps to assure their position in this legal matter.

Then, as to the second part of the proposition submitted by Mr. Edwards, it will be observed that he did not ask for the general publication of the report of the experts, but that it should be considered by a Committee of six stockholders in conjunction with the Lancashire Committee, whose superior position in regard to lay support was thus recognized. But the proposition was not favourably regarded by those who knew that, at this meeting, they tightly held the reins. So the experts' report is a closed book; and no one outside the Board as now existing, with the officers of the Company, and the experts concerned, knows what is in the report. No one, except those directly involved—past and present—in the administration of the concern, has been given an opportunity of forming any judgment as to what is best to be done in the interests of the Company. Among gas-qualified proprietors, there is much dissatisfaction over this concealment by a Board, members of which no doubt regard the pointing out by the experts of weaknesses in the affairs of the concern, and the directions in which it is possible to make improvement, as tantamount to censure of their administration. Who can blame proprietors who have been intimately concerned for the welfare of the Company, if they read into this reticence to disclose (and the elaborate precautions taken to prevent the disclosure of) the contents of the report, any other reason than that which is given by the Board? People will draw conclusions; and nothing can

prevent them. Certainly for six months, until March 21—that is ten days before the meeting—the proprietors were justified in anticipating that Mr. Dickens would give effect to the promise made in his circular of Sept. 27 last. In it he stated:

> I have come to the conclusion after due consideration that there is grave leakage somewhere. This, I think, is plainly evident to the ordinary business man. I have, however, the consent of the Board to send over an independent expert, if I wish to make a thorough investigation. It is impossible to have that report for the half-yearly meeting on Tuesday next (Sept. 30); *but as soon as I receive same, I will send you a copy*. If that report is of such a nature as calls for independent action on the part of the shareholders as a body, I will make it my duty to call them together to consult on the situation. The meeting in that case will probably be held in Manchester, as it would be a convenient centre for the shareholders generally.

Nothing further appears to have been heard by the proprietors until the issue by Mr. Dickens of his circular dated March 16, the posting of which was delayed for a few days in order that the circular might be received by the proprietors simultaneously with the Directors' report. All this time proprietors who were interesting themselves in the matter had a fair right to expect that Mr. Dickens would fulfil his two promises—to send out a copy of the report, and, if the report was of a nature to call for independent action on the part of the proprietors, to call them together to consult on the situation. What has happened in regard to the concealment of the report is well known. As to the promise to call the proprietors together if the report was of a nature to call for independent action on the part of the proprietors as a body, it is quite evident that it was of such a nature, as Mr. Dickens and his two Lancashire colleagues considered the administration of the Company required amendment by their presence at the Board. But, the September circular notwithstanding, they are on the Board to-day without ever having called together the general body of proprietors "to "consult on the situation." In the important matter of supplementing the Board—important in view of the position of the Company to-day—there was surely sufficient ground and reason for serious consultation. So far as Mr. Dickens is personally concerned, no doubt all independent proprietors appreciate what he has done, just as they do the criticisms in our columns of Mr. Edwards ("Nonulus"); but we do think with many others that it would have been wise on the part of the former gentleman to have given the proprietors an opportunity of associating themselves with him, through consultation, as he himself originally suggested. And many, we feel sure, will continue to entertain that view.

A Study of Gas Calorimetry.

On another page of to-day's "Journal" will be found a lengthy *résumé* of a voluminous paper by two American investigators, Messrs. C. W. Waidner and E. F. Mueller, on "Industrial Gas Calorimetry." It comes appropriately at the present moment, having regard to the fact that calorific value clauses will have to be settled in connection with a number of Bills in Parliament in the course of the next few weeks. On this account, many readers of the "Journal" will turn with special interest to the discussion of methods of gas calorimetry which is presented to them by Messrs. Waidner and Mueller.

The paper should well repay careful study. Evidently it embodies the results of many months of assiduous research; and it is certainly the most ambitious attempt at an exhaustive treatment of the subject of gas calorimetry since Mr. J. H. Coste published his treatise, entitled the "Calorific "Power of Gas," in 1911. The latter work was not faultless; but the accuracy of the observations recorded in it has not hitherto been questioned. Now, however, on such an important issue as the accuracy of the Boys calorimeter—which is the instrument used in the official gas-testing places in London—we find Mr. Coste and Messrs. Waidner and Mueller at variance. The latter scientists report that the observed heating values found by them with the Boys calorimeter were about 2 per cent. lower than those found with the Junkers calorimeter. Mr. Coste, on the other hand, found as close agreement as could be desired between these two types of calorimeter. What is the truth of the matter? It is scarcely conceivable that Mr. Coste's observations were so much at fault; and he used more than one specimen of the Boys calorimeter in his comparisons. On the other hand, the American investigators appear to have made their observations on one instrument; and it is conceivable that it was in some respect faulty. This is a matter on which, however, Messrs. Waidner and Mueller may be presumed to have taken all precautions; and if it is a fact that an accredited specimen of the Boys calorimeter gives results which are 2 per cent. low, it is clear that such an instrument should have no place in official testing-rooms. What have the London companies whose gas is at present tested by it to say on the point?

On the other hand, if Mr. Coste is right, and the Boys' calorimeter gives results which are identical with those of the Junkers, the observations made by Messrs. Waidner and Mueller become discredited, and their paper must cease to have any value as a contribution to the literature of gas calorimetry. We would fain believe it otherwise; because a comprehensive review of different calorimeters such as they essay to give should be very useful at the present juncture, when so many gas companies and local authorities are considering how they should ascertain with accuracy the calorific value of the gas they supply.

On one point there can be no room for a second opinion. The mode of calorimetry to be adopted must be capable of ascertaining the total gross calorific power of the gas. A perusal of the *résumé* of the paper by Messrs. Waidner and Mueller may leave the impression that this is a difficult and troublesome matter to accomplish. But in this country at least, there is an apparatus which aims at giving directly the total heat value of the gas, however much the conditions of temperature and humidity of the air of the testing-room may vary. As a matter of fact, these variations in a room in this country are not so great as in many parts of the United States of America; and such an extreme case as a temperature of 95° Fahr., and a humidity of only 10 per cent. (for which Messrs. Waidner and Mueller incidentally give a correcting factor), will certainly never occur here, though it may not be impossible in New York. When, however, we regard the formidable provision of correcting factors and tables which these authors make, in order to obtain the total heat value from the observed values of ordinary gas calorimeters, we are more than ever convinced that the instrument to be employed in future must be so designed, and in practice must be so used, as to be self-correcting.

Yields and Qualities of Tar and Liquor.

If one studiously follows up Dr. W. B. Davidson's contributions to the subject of coal distillation and the derivatives, there is found in them a continuity along the main road, and developments in the side-paths. Last Saturday, the Western Division of the Scottish Junior Gas Association were fortunate in having Dr. Davidson to lecture to them on questions relating to tar and liquor; and this lecture may be taken as an extension of what we have heard before from the same source on carbonization topics. The lecturer was one of the very first in the gas industry to boldly assert that insufficient attention was given in most gas-works to the quantities and qualities of the secondary products of coal carbonization, and that no carbonizing system had its merits properly assessed if account were not taken of the yields of tar and liquor—quantitatively and qualitatively. He and others have substantiated the allegation before; and the proof is accentuated in the present lecture. In its opening part, there is plain statement of the fact that it is exceptional to find two carbonizing systems, *cæteris paribus*, differing in gas production to the extent of 10 per cent., while a difference of as much as 40 per cent. is sometimes found in the yield of tar, and as much as 20 per cent. in the yield of liquor. This demonstrable assertion cannot fail to induce one to follow up what Dr. Davidson has to say upon this matter. The point is further emphasized on the financial basis. Take 4 gallons of tar at 2½d. per gallon, this is equivalent to 10d. per 1000 cubic feet cost price of gas in the holder, *plus* profit. Thus it is not correct—yet how often is it really done!—to adjudge the suitability of any carbonizing system on gas and fuel data only. They are not the final or conclusive factors in the matter; but overall results should be taken, including the secondary products, under the individual conditions of any gas-works. There may be a disposition in some negligent quarters to pooh-pooh, as finical, the attitude taken up on this matter; and to say that time is too limited and occupied to give the scrupulous care advised to matters that exist under the disadvantageous designation of "secondary." These matters really take rank as of primary importance when we come to calculate the net cost of coal, or the net cost of gas into the holder, which is the true criterion of a gas-maker's ability. But it is waste of time to argue with those who are supine

over the bye-products. It can only be hoped that such lectures as the one before us will have an awakening influence, and cause those who are indifferent in this matter to simultaneously mend their habits and improve the fortunes of their concerns. For the indifferent ones, Dr. Davidson has only one remark; and, as is his mode, the stricture falls in the politest of forms. "I believe," he says, "there is a "tendency to pay no particular attention to the production "of tar and liquor; but simply to trust to luck." There is a good deal of quiet censure in these words.

Having selected the proper carbonizing plant to give, consistent with a good production of gas, the highest yields of tar and liquor from the coals purchased, it is not the slightest use then to let the plant take care of itself in regard to the yield of tar and liquor, as there is—we will not say generally, but, as the lecturer puts it, a "tendency" to do. The plant must afterwards be kept in as perfect condition for tar and liquor production as it is for gas making; and then supervision over the products should be maintained and records kept as systematically as is done in the case of the coal used, and the quantity and quality of gas produced. It is only by method that proper track can be kept of the working in regard to tar and liquor; and that method may mean much in profit at the end of the year. In respect of systematic measurement and control, the tar and liquor, of course, suffer a disadvantage in comparison with the gas made, in that measurement is not such an easy matter. Heavy stocks form an obstacle to exactitude; the determination of the line of demarcation between tar and liquor is another difficulty; and errors have an unfortunate knack of cropping-up in connection with the measurement of the varying content of wells and tanks. It would be interesting if readers who keep a systematic record of the tar and liquor, and not a simple rough-and-ready calculated one (which is open to all sorts of error, especially if working results are computed with test results as the basis), would describe in our columns the methods they have adopted.

In his lecture Dr. Davidson advises that monthly returns should be kept, as in the case of both gas and fuel. He describes a method of doing this, so as to denote variations in ordinary working, and variations from the results of a test-run, deliberately conducted to get the very best returns. Unless strict surveillance is maintained in this way, there are no means of judging whether or not results are good or bad, nor to ascertain why there has been at any particular time a decline in the results. It is important that a standard should be fixed, from which judgment can be made as to whether in actual working results are good or indifferent. The small laboratory coal-testing plant is not the slightest use for this purpose. The measurement of the tar and liquor on such small-scale working is not easy, and the results are unreliable. A special test should be instituted on a considerable scale—in fact, Dr. Davidson advocates that as much as 50 tons of coal should be dealt with, evidently with the idea of obtaining a reliable average per ton. This would be a test erring rather on the large scale for some works; still Dr. Davidson is right when an absolute determination of top results, compatible with gas yield, in respect of tar and liquor is required. Results specially obtained in a strictly supervised trial-run not only serve to check day-by-day working, but by their aid an interesting study can be made as to the effects of different carbonizing plants (where such exist) upon the production and composition of the tar and liquor, and upon the effects of different temperatures and conditions of settings and working, as well as allowing comparison to be made of the results obtained under such conditions from different sorts of coals. Systematic working of the kind must result in improvement and its maintenance. Dr. Davidson sets out figures in the lecture which show the departures, *plus* and *minus*, in actual working from the results obtained by test plant. But it would have been interesting if he had specifically stated what he believed were the causes of these variations.

Some of the statements in the lecture must not be taken as *dicta* to be adopted without qualification. For instance, in one place Dr. Davidson says, by increasing the weight of coal carbonized in a given time, with augmented temperatures, the production of tar is increased at the expense of the gas. This does not always follow; the whole conditions of the settings and working have to be taken into account. Right in the fore part of the lecture we get the fact, in tabulated form, that retorts working 9½ cwt. charges in eight hours at a temperature of 1950° Fahr. gave tar and liquor results below their direct-fired predecessors carbonizing, at a temperature of 1600°, 4¾ cwt. in six hours; and results also fell below the test-plant returns. There we have a case in which the increase in the weight of the charge, using new type plant and higher temperatures, did not enhance the production of tar or liquor. The new retorts were fitted with one ascension-pipe; and though we do not gather from Dr. Davidson that he attributes to this fact the substantial falling off of tar and liquor from the test results in this instance, still the single ascension pipe does affect detrimentally the make of both the tar and liquor, as well as in an undesirable manner the naphthalene and carbon bisulphide, though *per contra* the make of gas may be improved. Of course, low-temperature carbonization favours the yield and quality of tar in respect of specific gravity, low free carbon content, low yield of pitch, and high content of middle oils. Heavy charge working, under ordinary conditions, has a similar good effect on quality; and so has vertical retort working. But light charges and high temperatures are baneful to quality—a tar of high specific gravity, and high in free carbon and pitch, being the result. On the other hand, under the low-temperature conditions, there is a considerable reduction in the yield of liquor—only (say) 24·8 gallons, as compared with 35 to 36 gallons at ordinary temperatures. Again, temperatures for the yield of ammonia must be neither too high nor too low. Therefore, to realize the maximum profit from a ton of coal, the business of the gas maker must not be to simply run his temperatures up to the point which will give him the greatest yield of gas of the quality he has to supply, but his equipment and working should be on such lines as will give him from the aggregate of the derivatives from the carbonization, the maximum total value.

There are many other matters in this lecture; the topic touched upon—the yield and quality of the liquid products—being only the main one. And the chief lesson to be drawn from it all is that it is only by a complete study of coal carbonization and the products, with continuous systematic supervision and record, that the most profitable results can be realized. Towards the end of the lecture, Dr. Davidson describes some quite simple apparatus that he has devised for the testing of tar and liquor.

Undue Preference.

The hearing of the Long Eaton case, in which the Gas Company have been asking Mr. Justice Sargant to say that the District Council are acting *ultra vires* in respect of the discrimination they make between electric power users who employ electricity for lighting purposes and electric power users who favour gas as their means of lighting, ended last Tuesday; and his Lordship will probably deliver his judgment in the course of next week. Towards the latter part of the case, he intimated that he hardly thought the evidence that had been submitted to him was sufficiently strong for final determination to be made one way or the other, in view of the importance of the matter. One of the witnesses called on behalf of the Gas Company stated that he received notice from the Council that, unless he used electricity for lighting, he would have to pay more for his power supply, and this was the only reason that induced him to change from gas to electricity. Another electric power user stated that he had the cost of his power supply reduced by taking electricity for lighting purposes in place of gas. The power supply for all these factories is taken "under similar circumstances," and therefore the Gas Company contend that an "undue preference is shown to a power user who, by consuming a comparatively small amount of current for lighting, gets his power supply at ¾d. per unit, as against the 1d. per unit charged to the power user who employs gas for lighting. There are many points that tempt comment in the case; but the matter is for the present *sub judice*.

The Duties of Auditors.

On being asked by the Directors of a certain company to report on the financial position of the undertaking and make recommendations for putting it on a sound footing, the auditors advised that, in order to pay off a bank loan, the preference dividend should be suspended; and they also pointed out the necessity for making adequate provision for depreciation and for the raising of further capital for extensions. For the performing of this useful service, as the result of a definite request to do so, the auditors were subjected to criticism in certain quarters.

This, however, is a view of the matter which is not shared by the "Accountants' Journal," which, while admitting that it is no part of the duty of auditors, as such, to interfere in the management of a business, urges that, if the directors desire expert financial advice, and consider that chartered accountants are the experts best able to give an opinion to guide the board, surely the company's own auditors, who are familiar with the business, are more likely to prove of service than an outside firm. Not only does our contemporary thus support the auditors in their action in acceding to the request made to them by these directors, but it also supports the board in their decision to seek this expert advice, when uncertain themselves as to the right course to be adopted. This appears to be a perfectly reasonable way in which to regard the matter; and, as is pointed out in the article, it is only following the same course as is adopted in connection with other questions. Engineering experts, it is said, are frequently called in before capital expenditure is embarked upon, building experts for erecting new works, and the help of legal experts is sought before prosecuting any action in a Court of Law; and chartered accountants, from the very nature of the training they undergo, and the experience they gain, are undoubtedly entitled to pose as experts in financial matters. The writer goes on to assert that many concerns would be in a happier financial position to-day if they had sought the help and counsel of their auditors. In instances in which auditors felt that they could give useful advice, they would no doubt feel disinclined to withhold it, if it were asked for.

Education in France and Germany.

A report which is worthy of consideration by those concerned with educational questions in this country has been issued by the Education Department of the London County Council. This report has been prepared by Mr. J. C. Smail, the Organizer of Trade Schools for Boys; and it deals with trade and technical education in France and Germany. It is the result of a visit which the Council instructed Mr. Smail to pay to Paris, Munich, Leipzig, and Berlin; and much useful information can be gleaned from it. In an introduction, Mr. R. Blair, the Education Officer, says that the Paris professional trade schools are training foremen, leaving them to train the workmen in the shops; whereas the German continuation schools supplement apprenticeship, and are aiming at the uplifting of every man in his fourfold aspect of member of his trade, member of his family, member of the community, and member of the State. The report, he points out, shows how in Germany the State, the municipality, the employed, and the employer have all come to believe in education of all types, including compulsory continuation education. The State and the parents have both adopted the long view—the former in looking forward to the ultimate value of the work of the schools, and the latter in foregoing immediate wage returns of their children for future prospects. In the towns mentioned, and other places in Germany, the organized efforts of the State and the municipality are, it is declared, reaching every boy in a way that would hardly be credited in England, but for the fact that experienced officers have seen it in operation. One important point to be gathered from the report is that Germany is systematically dealing with the problem of training teachers for technical work. Mr. Blair remarks that the British method makes the best top, and also produces the worst tail; while it does not do much for the general raising of the great mass of workers. The average number of hours' attendance made in a session by the evening student is nearly five times as great in Germany as in England; and, in addition to this, the German boy must take three or four years' continuation course. On the other hand, "the English boy may take as much as he pleases; and 75 per cent. between 14 and 17 either cannot or do not please even for one year."

Obituary.

Mr. WILLIAM PRESCOTT, J.P., a well-known public man in Leigh, Lancs., died last Tuesday, aged 67. He was a Director of the Golborne Gas Company, and for a great number of years was a member of the Leigh Board of Guardians.

After the present issue of the "JOURNAL" had gone to press, the sad news reached us of the death, last Sunday, of Mr. ALEXANDER ALLAN, Engineer and Secretary of the Scarborough Gas Company—a position which he had occupied for nearly thirteen years. He leaves a widow and one son, Mr. Philip Allan. We are unable to do more to-day than make the above announcement, which, we are sure, will be read with much regret by his many professional colleagues and personal friends.

PERSONAL.

At last week's meeting of the Royal Institution, Mr. F. W. GOODENOUGH was elected as one of four new members.

Among the announcements of births in "The Times" last Wednesday, there appeared the following: "On the 6th of April, at No. 3, Sloane Court, London, the wife of CYRIL G. DAVIS, of a daughter."

The Directors of the Brynmawr and Blaina Gas Company have appointed Mr. Leonard Murray, the Assistant-Manager of the Garw and Ogmore Gas Company, Aberkenfig, to be Manager of their works at Blaina.

We learn that Mr. WILLIAM ROGERSON, the Gas Manager to the Bollington Urban District Council, has been appointed to the position of Gas Engineer and Manager to the Middleton Corporation, in succession to Mr. W. H. A. Chester, who, as already announced, resigned to take up the post of Deputy-Engineer to the Brisbane (Queensland) Gas Company.

The Hon. GEORGE SWINBURNE, of Melbourne, has been transferred from the class of associate member to that of member of the Institution of Civil Engineers; and the following were last Tuesday elected associate members: Mr. A. D. ANDERSON, of the Belfast Corporation Water Department; Mr. SAMUEL HALL, of the Aberdeen Water Commission; and Mr. W. L. HAMILTON, of the Antofagasta (Chili) Water-Works.

Alderman JAMES FERNELY, J.P., has intimated his intention of resigning the position of Chairman of the Stockport Gas Committee, which he has held with conspicuous ability for the last decade. Some time ago, says our Manchester correspondent, Mr. Fernley announced his intention of relinquishing the office; but as there were several important matters pending in which his experience as Chairman was invaluable, he was persuaded to postpone his resignation.

The retirement of Mr. T. C. FULLER from his connection with the Isle of Thanet Gas Company took place on the 31st. ult. Mr. Fuller had been Secretary of the Company for forty-five years, and in that time has seen many changes affecting the gas industry in general and the administration of gas matters in Thanet in particular. When he joined the Company, gas was being supplied by them to both Ramsgate and Margate; but in 1877 the Ramsgate portion of the undertaking was sold to the Corporation. Since 1877 the Thanet Company have supplied gas to Margate, Garlinge, Northdown, and a part of Westgate; and it may be noted that the make of gas has increased from 50 million cubic feet to 392 millions last year. Mr. Fuller is a native of Ramsgate; and, after the regularity of his attendance in Margate, a friend remarks, he will be much missed by many in the town where he is so well known and universally respected. The Directors have appointed Mr. A. J. STICKELS, who has been Assistant-Secretary for the past eleven years, to fill the position.

PRESENTATION TO MR. H. E. COPP.

AN interesting presentation was made on Thursday last to Mr. Harold E. Copp, at a largely attended meeting of the employees of the West Bromwich Gas Department, prior to his leaving to take up his new position at Hanley. The chair was occupied by Mr. F. E. Cox (Assistant-Manager), who proposed the health of Mr. Copp, and handed him a handsome hall clock, upon which was the following inscription:—

> Presented to Mr. Harold Copp by the staff and employees of the Corporation Gas Department, West Bromwich, as a token of the high esteem in which he was held during the 12½ years he occupied the position of Engineer and Manager. April 9, 1914.

Mr. Cox said it was one of the most pleasant duties he had ever performed, because during the time he had been at the gas-works he had always found Mr. Copp an excellent chief. They were now about to lose him; but they fully realized that what was a West Bromwich loss was Hanley's gain, and that he was going away to continue his very successful career. He did not think, however, that Mr. Copp would easily forget West Bromwish or his many friends at the gas-works; and on behalf of the employees and the staff, he wished him all future health and happiness, and a long and most successful career. The clock would always remind him of his friends among the employees at the gas-works, some of whom came to him (Mr. Cox) and suggested they should make a presentation, before he even thought about it himself. To have such a request from employees only increased the pleasure it afforded him to testify in this way to the services of Mr. Copp and his kindness to them all.

Foreman Thompson supported the toast, and joined in the expression of goodwill towards Mr. Copp; and Mr. Field, on behalf of the outdoor department, also spoke.

In returning thanks, Mr. Copp said they had placed him in a very peculiar position. He always found a difficulty in expressing in words his feelings on such occasions; and that night it was especially hard for him to do so. He had just been honoured in a unique way in West Bromwich, for he had been presented with a testimonial from the Town Council under its official seal. He

appreciated very much the action of the Council, though he had a feeling that he was honoured beyond his deserts. But that night the honour they had conferred upon him had touched him more than anything else could possibly do, because he felt he had the goodwill of those with whom he had been associated for the last 12½ years. As most of them would no doubt realize, his position at times had been a rather difficult one. He had had to serve three masters—he had had to serve the interests of the employers, those of the employees, and to some extent his own. Therefore they would perceive he had had no easy task; but he had always endeavoured to discharge his duties to the whole of the three interests in a really satisfactory manner. He had tried to do justice to those whom he had had the honour of controlling as well as those whom he had had the honour to serve. He could only hope that Mr. Johns would be as successful in securing their goodwill, and in working harmoniously with them, as he had. From what he knew of him, he ventured to predict that he would be a man who would do justice to the employees as well as to the employers. The uppermost feeling in his own mind that night was that he was about to leave West Bromwich and some of his best friends, who were to be found among the employees of the Gas Department. He assured them that their beautiful gift would be his most treasured possession, because it was an expression of the goodwill and esteem of those whom he had controlled at the gas-works during a long but exceedingly happy period of service.

A PRESENTATION AT HARROGATE.

At a meeting of the employees at the Harrogate Gas-Works the other evening, to celebrate the completion of his 35 years' service with the Harrogate Gas Company, Mr. G. S. Sayner, the Engineer, was presented with an elaborate marble timepiece, as a mark of their esteem and regard, with the following inscription thereon:

> Presented to G. S. Sayner, Esq., by the employees at the Harrogate Gas-Works, upon the completion of 35 years' service with the Company. March 31, 1914.

In making the presentation, the Chairman and Mr. John Healey, one of the longest service men (27 years), remarked that it was the wish of all subscribers to express their deep regret at losing Mr. Sayner as their Engineer. They had always held him in high esteem; and they wished him every success in his future undertakings. The Secretary and General Manager also wrote desiring to be included in the expressions of goodwill; Mr. J. W. Jackman, the Assistant-Engineer, reading the letter at his request.

Mr. Sayner suitably responded. Speaking with emotion, he said this was an occasion of sadness and pleasure mixed—sadness in having to part from such loyal men and comrades in working together for the success of the Company they served, and pleasure in appreciation of so unexpected and spontaneous a demonstration of their goodwill as exhibited in the splendid gift before him. Wherever his lot was cast, it would ever remind him of such good feeling in loyalty and esteem; and he wished to take this occasion of thanking Messrs. Jackman, Deightons, Elsworth, and all for their help and support through the various difficulties with which they had had to contend up to, and including, the introduction of, and preparation for, the installation of the latest method of carbonizing plant, and from which he hoped they would realize the benefit of improved working conditions.

An American Committee on Electrolysis.

A Committee consisting of representatives of the American Electric Railway Association, the American Railway Engineering Association, the National Electric Light Association, the American Telephone and Telegraph Company, the American Institute of Electrical Engineers, the National Bureau of Standards, the National Gas Association, and the American Gas Institute, has been organized for the study of electrolysis. Mr. B. J. Arnold, of Chicago, is the Chairman, and Dr. E. B. Rosa the Secretary; and Professor A. F. Ganz, with Mr. J. A. Gould and Mr. J. D. von Maur, represent the Gas Institute. Mr. Calvert Townley, the Chairman of the Plan and Scope Committee, gives the following outline of the work intended: "Electrolytic controversies have in the past given rise to unnecessary and acrimonious disputes, and have not infrequently resulted in litigation between the corporations concerned. The usual procedure in disputes has been for each side to employ one or more electrical experts, who generally disagree as to the cause of the trouble and the remedies therefor. The dispute often gets into the newspapers, occasioning unpleasant notoriety, and resulting in drastic action by the municipal government concerned. Much of this could be avoided if a body such as this Committee could be created to consider broadly the questions covered by the controversy, without attempting to pass judgment upon the questions at issue, and to report back to their organizations, so that in time the Committee would come to be recognized as a neutral body whose decisions would be authoritative, the same as the Standards Committee of the American Institute of Electrical Engineers in connection with matters of definition and standardization, which is a recognized authority that no one attempts to question. It is not the purpose of the Committee to act as an arbitration board in controversies, thereby taking the place of executives or the courts."

NOTES FROM WESTMINSTER.

There is a partial respite from Parliamentary Committee work. There was nothing done last week after Tuesday; and although the House of Commons meets again to-day, there will not be much doing in the Committee rooms before next Tuesday. Certain Commons Committees in which we are interested will then begin or resume work; but it will be quite a week later before the House of Lords Committees will continue their part of the proceedings on Private Bills.

High-Pressure Meter Testing. The London County Council (General Purposes) Bill, in which legislation is proposed for the Metropolis regarding the testing and stamping of high-pressure meters, has been before Sir C. Nicholson's Committee; but at the time of the adjournment last week consideration was being given to the question of the dangers of celluloid and the storage of films. The Committee will be re-assembling to-morrow. The three London Gas Companies have petitions against the high-pressure meter clauses, in which they contend that, at the present stage of the high-pressure gas business and the development of high-pressure meters, and in view of the existing agreements under which gas is supplied at pressures higher than the ordinary, the time is not opportune for imposing legislation. When legislation is applied, it should be general; and a good length of time should be allowed before any change is made, in order not to disturb current agreements. This is a subject that was recently dealt with in our editorial columns.

Calorific Power. From information received, we have in directly intimated the possibility of some of the Metropolitan Borough Councils making a move in an effort to secure the retention by the Gas Light and Coke Company of the illuminating power standard and test in addition to the calorific power one. The Bill is down for consideration by a House of Lords Committee whose sittings begin on the 28th inst. The St. Pancras Borough Council, as will be seen from a paragraph elsewhere, have circularized other Borough Councils to ascertain the attitude they respectively propose to take up in regard to the matter. The Hammersmith Borough Council have replied that they are only proposing "passive resistance;" but they state that they do not consider it is in the interests of the consumers of gas that the illuminating standard, and the penalties for deficiencies, should be removed. It is interesting to observe that the borough councils that seem most concerned over this question are those running electricity supply undertakings in competition with the Gas Light and Coke Company. Is it self-interest, or really (on mistaken grounds) in the interests of the gas consumers, that they want to maintain the dual standard for gas supply, while their own electricity supply is not subjected to any tests or penalties, other than the tests they, at their own sweet will, choose to make? Of course, as electricity suppliers, they would prefer to see the Gas Light and Coke Company tied hand and foot, and to obstruct every proposition for relief from conditions that are against freedom in working, and the ultimate reduction in the price of gas. Such opposition is not in the interests of the gas consumers; it is in the interests of the electricity concerns of the borough councils.

Miscellaneous. Several petitions against the South Suburban Gas Company's Bill have been withdrawn; and this is understood to be due to the dropping of the limited electricity power supply scheme of the promoters. The Bill is in the group of measures now under the consideration of Sir Harry Samuel. Owing to the immense opposition, to the absence of cohesion on the subject between the Electricity Supply Companies of London, and to the hostility of the London County Council and others, the Bill promoted by the County of London Company and backed by two or three firms of bankers, it is understood, has been withdrawn—anyway, for the present. The Bill, it will be remembered, proposed to get an extension of the period (which under present circumstances ends in 1931) before the London County Council could purchase the undertakings, and to provide a bulk supply of electricity from a large station to be established at Barking. The bankers, in conjunction with this scheme, were proposing a "holding Company" to which shareholders in the electric supply companies could transfer their shares. In this way, we take it, it was intended to obtain, through one company, a controlling power over the electricity supply concerns in London not under municipal management. The scheme, however, has been withdrawn. In view of the activity of the London County Council, the investigation of the electrical situation in London on their behalf by Mr. Merz, and the plans that he proposes for dealing with it, there is not much likelihood of the Company's scheme being revived, or, if it were, of any success accompanying the revival.

The Loose Case of Deal and Walmer. The comments made last week upon the case presented against the Deal and Walmer Gas Company's Bill, and especially in opposition to their application for electricity powers, were fully justified by the decision of Sir

Harry Samuel and his colleagues, and the character of the final evidence presented to them by the opponents last Tuesday. The Committee were impressed, as we were, with the looseness and obvious insincerity of the local authorities. The Mayor of Deal gave the whole game away during his cross-examination by Mr. Honoratus Lloyd, K.C., and in his replies to incisive questions by the Chairman. His Worship considered that there was not a sufficient demand for electricity to justify an installation, yet he was prepared to pledge the Corporation to apply for an Order at once to carry out a scheme if the Committee would only declare the preamble of the Gas Company's Bill not proved in respect of their electrical scheme. But he had no resolution of the Corporation, or any mandate from the ratepayers, authorizing him to make his pledge. He agreed that, as there was not sufficient demand to justify an undertaking, the ratepayers would, for at any rate a few years, suffer loss; and he was prepared to face this loss whatever it might be in order to provide competition with the Gas Company. This is an illustration of local administration run mad. The ratepayers of Deal will hardly be prepared to allow an authority who put up so bad a case before the Parliamentary Committee to enter upon such a career of speculation and loss as proposed by the Mayor. It was a tissue of indefiniteness and indecision all through; and the Committee had not sufficient faith in the local authorities to justify them in declaring the electricity part of the preamble of the Bill not proved. However, the Committee have given the two Corporations an opportunity. They have restricted the electricity supply powers to Deal and Walmer, and have placed upon the authorities a time-limit of twelve months within which to obtain authority to buy up the Company's electricity powers. At the same time, the Committee did not stay the hands of the Gas Company, and intimated that the latter would have to be refunded all the money they spent. If the local authorities commence a campaign among the ratepayers to obtain authorization to promote a Provisional Order to acquire the electricity powers within a year, which will, we suppose, include the Company's obligation to substantially start the scheme within two years, it will only require extracts from the local authorities' evidence on the Gas Company's Bill to give any such purchase scheme complete quietus. The Committee sat late on Tuesday, in order to finish the case; and clauses will be considered to-day week.

ELECTRICITY SUPPLY MEMORANDA.

THERE is very little prospect of the Wiring and Fittings Bill of the Incorporated Municipal Electrical Association making any headway this session; and it is pretty certain that, when the measure is taken seriously in hand, it will, before it proceeds very far, assume an altogether different aspect from that now presented by it. The promoters are not looking for much sympathy from the House of Lords; but they are rather hoping to get the House of Commons to look benignly on their efforts to obtain greater power in the matter of speculative electrical trading by local authorities. Past parliamentary history of affairs in this matter does not, it seems to us, justify the promoters of the Bill in leaning their hope too heavily on the House of Commons; and the members of the Local Legislation Committee have just indicated that there is no relaxation on the part of the House over this matter of the extension of municipal trading to electrical wiring and fittings. Whatever is done must be on the terms of the model clauses. In the Barnsley Corporation Bill this session, the model clauses were adopted, with the addition of some rather significant words, which are denoted by italics in our extracts from the Bill. "The Corporation may, subject to the provisions of this section, *purchase*, sell, let for hire, and fix, repair, remove," &c. The word "purchase" is not in the model clause; and we cannot see how, except by stealing, local authorities can sell and let for hire apparatus if they have no right of purchase conferred upon them. Perhaps the point is covered later on in the model clause, where it says that the local authority "may provide all materials and work necessary or proper in that behalf," &c. But a more serious interpolation appeared in subsection 2 of the clause in question in the Barnsley Bill. "The Corporation shall not sell any such electrical fittings (*other than electrical fittings which at the time of sale are let on hire to the consumer purchasing the same*), except through a contractor carrying on business independently of the Corporation." There we see how neatly the Corporation could have over-ridden the intentions of the model clause. But the Local Legislation Committee would have no departures from the terms adopted by the Parliamentary Authorities; and they ordered that the clauses should be adjusted strictly to the model form. This does not look very hopeful for the Municipal Electrical Association Bill gaining for local authority electricity suppliers anything beyond what is conferred by the model. Our friends of the electrical industry must not overlook the fact that the model fittings and piping clauses applying to municipal gas undertakings are on identical lines to those applying to municipal electricity undertakings; and were any changes made in favour of municipal electricity, municipal gas undertakings would see to it that the piping and fittings clauses applying to them were made equally elastic.

Model Fittings and Wiring Clauses.

Electric Cooking at Reading.

When there is great similarity in articles published simultaneously in the electrical papers describing the installation of a piece of electrical apparatus, it may be safely stated that the article is really an advertisement for the goods—though, we do not suggest, an advertisement that is paid for. Obviously an advertisement article of this type is an account that has appeared in most of the electrical papers of an installation at St. Patrick's Hall, Reading, of the "Eclipse" restaurant type of electric-oven made by the Electric and Ordnance Accessories Company, Limited, of Aston, Birmingham. St. Patrick's Hall is a large residential place in connection with Reading College. As the gentleman in charge of the hall is an Assoc. M.Inst.E.E., we have an explanation as to the presence of the "milk in the cocoa-nut." No doubt he has done all he possibly can to make a success of the electric oven installation; but there is little pronounced evidence of this success in the articles before us. All the information given on the point of success in the article as published by

> The "Electrical Times" is: The equipment, which is supplied from the Reading Company's 200-volt d.c. mains, has given most gratifying results ever since it was installed, the management having expressed themselves as being highly satisfied.
>
> The "Electrician" is: The equipment, which is suitable for use on a 200-volt circuit, has given most gratifying results, the management having expressed themselves as being highly satisfied with the "Eclipse" ovens in every way.
>
> "Electrical Industries" is: The equipment, which is suitable for use on a 200-volt circuit, has given most gratifying results ever since it was installed, the management having expressed themselves as being highly satisfied with the "Eclipse" ovens in every way.

This is evidence that the authority for the "most gratifying results," and for the management being "highly satisfied" is one and the same person, and that our electrical contemporaries before publishing the statement did not exert themselves to investigate its truth. It is rather curious that, if there have been no trouble and no drawbacks experienced to mar the "most gratifying results" that something more definite was not said about the latter in the article.

The Pretenders.

The "Electrical Times" opens the article by mentioning that the Reading Electric Supply Company, Limited, were one of the first to adopt the 0·5d. tariff for heating and cooking; and the Company are still one of the few that have the courage to apply this low rate without any primary charge based on rateable value or kilowatt capacity installed. Following this, we read—this being true "Electrical Times" fashion in dealing with the subject—"it is not surprising, therefore, that consumers are not slow to avail themselves of the advantages of electric cooking and heating." We should like to know something more about this rush in adopting electric cooking and heating, because knowing something of the affairs of the borough of Reading (although not resident in it), we have failed to trace the symptoms of this marked haste to adopt electric-cookers. A few have been fixed; but would the Electrical Engineer (Mr. E. Rowley Hill, Assoc.M. Inst.E.E.) kindly inform the electrical press whether the use of any of the electric-cookers has been discontinued, and if so, how many out of the total fixed? We referred to this matter on Jan. 6 last (p. 15). It seems that the "Electrical Times," in speaking of this hot haste to use electric-cookers and heating, with current procurable at ½d. per unit, considered there was safe authorization for the assumption in this: "The units sold during 1912 over those supplied in the previous year represent an increase of nearly 54 per cent., mostly due to the *power and heating load*." Is any increase in the current sold for power sufficient grounds for the assertion that "consumers are not slow to avail themselves of the advantages of electric cooking and heating?"

The Accounts of a Point-Five.

Looking into the accounts of the Reading Company for 1913, we do not see any startling signs of a mighty rush in the adoption of electric cooking and heating appliances. On the contrary, though the sale of current increased by 167,517 units in the twelve months, the financial position shows no improvement whatever. If we consider the item under distribution: "Wages to linesmen, fitters, and labourers, £154 7s. 4d.,' this does not strike us as indicating anything like a mad rush for electric-cookers by the residents of Reading. Nor does a 3½ per cent. dividend (less tax) on the ordinary shares suggest itself as sufficient for a trading enterprise of this character. In passing, we notice the amount required for dividend for 1913 is only entered at £4860, against £5161 a year ago. Does this mean that £301 income-tax has been omitted in order to show a better balance forward, or has it been included under rents, rates, and taxes? For electrical energy £20,457 was received, as compared with £19,326 in the previous year; but the average receipts per Board of Trade unit declined from 1·99d. to 1·97d. The revenue from other sources is assisted by a credit of £150 for apprentice fees. Not a penny must be wasted in making up these accounts. The generating expenditure last year totalled to £6938, against £5947—the cost per unit being 0·67d., as compared with 0·62d. The total expenditure for the year reached £12,763, as compared

with £10,935, or 1·23d. per unit, against 1·13d. per unit. Depreciation has again had allocated to it £3500, or 0·34d., making the expenditure 1·57d. per unit, against 1·49d. per unit in 1912. The 1·57d. is without dividend charges 0·47d., and interest on loans 0·02d. (less interest on investments, 0·04d.)—making 0·45d. per unit. Adding this 0·45d. to the 1·57d. expenditure, we have 2·02d. per unit. This being so, what justification is there for Mr. Rowley Hill selling current at 0·5d.? Among other features of the accounts is the one that the balance of revenue available for dividend on the working of 1913 is £4511; but dividend and interest (without considering the point raised as to income-tax) require £5062, or deducting the interest on investments, £4691; so that the year's revenue—despite the fact that £1131 more was received from current, and the additional cost of coal was only £992—was £180 short of the sum needed for dividend and interest. The shareholders of the Company were far better off when the concern was doing a much smaller business.

Low Rates for the Cottager.

Some of the professional men of the electrical industry have set themselves the difficult task of trying to make their fellows believe that electricity can be supplied to cottagers at a lower rate than to ordinary lighting consumers, or even to the large user of electric light. They are finding sceptics among their fellows. In a paper that Mr. W. Fennell recently read before the Birmingham Section of the Institution of Electrical Engineers, he told how at Wednesbury he is supplying some 250 cottage consumers; and he makes out that the cost of the electricity supplied to these cottages only works out to 8s. 5d. per 100 units, or 1·01d. per unit. The question naturally arises, Why not treat the other lighting consumers, who use more energy and for longer lighting hours, on the same (or even better) terms, less all the charges incurred on behalf of the cottage consumer that are not applicable to the ordinary consumer? The revenue account that Mr. Fennell presents works out as follows:

			Per Annum.
Electricity—			
Kilowatt charge (45 watts at £7 per kilowatt)	£0 5 6		
Unit charge (100 units at 0·35d.)	0 2 11		
		£0 8 5	
Lamps—			
Two metal filament and one carbon		0 4 3	
Repairs		0 1 0	
		£0 13 8	
Income—			
52 weeks at 7½d.	£1 12 6		
Less collectors' commission, 7 per cent. 2 4 Less bad debts, &c., 3 per cent. 1 0	0 3 4		
		1 9 2	
Profit per consumer		£0 15 6	

This is a very pretty picture. Few electrical engineers can agree that Mr. Fennell has done his kilowatt charge justice. In reply to the discussion, he could give no information as to the actual consumption per house; he only thought there was very little waste in the houses. Altogether the scheme appears to be about as indefinite as it possibly could be, in regard to reliable information as to whether the supply to cottages is of advantage or otherwise to the electricity undertaking. Other figures were criticized in the course of the discussion; and a very pertinent point was made as to whether such a scheme would be welcomed in the case of an undertaking with a heavy lighting peak and a small power supply. There does not seem to be any charge for capital expenses or renewal of wiring and fittings, other than lamps, in the revenue statement. The houses are dealt with in blocks—one service to a block of five to fifteen houses. The cost of the service averages 15s. per house. Wiring and fittings, without lamps, cost £1 10s. to £1 13s. 6d. per house, which does not say much as to the character of the installation. Two 40-watt (under 30-candle power) metallic filament lamps are used, and one 8-candle carbon lamp. Three lights in all! Poor cottagers!! Only one bedroom is supplied with a lamp; the others have to do the best they can without one. That is all the cottager gets for his 7½d. per week. The average income is realized by the following charges: June and July, 5d. a week; May and August, 6d.; April and September, 7d.; March and October, 8d.; February and November, 9d.; and January and December, 10d. Well, the cottager who pays so much for such a little light, when he can get so much more from gas, is an enemy to himself; and the electricity concern that takes on "business" on the lines laid down by Mr. Fennell—well, that is a matter about which perhaps the less said the better, as whatever was said might be taken as personal. Anyway, the engineers who heard the paper were not mightily struck by the suggested soundness of the scheme.

Another View.

Simultaneously with the reading of the paper, Mr. A. W. Barham contributed an article to the "Electrician," in which, from his experience at Watford, he expresses a doubt as to the profitableness of supplying these small consumers. The "Electrician" summarizes Mr. Barham's position and contentions as follows: The author points out that, in the case of the smaller class of electricity works, the cost of giving a supply to a small consumer, who is liable to use only 55 units per annum, amounts to 20s. 2d. with an ordinary meter, and 23s. 2d. with a prepayment meter, whereas the revenue with electricity supplied at 4½d. per unit is 20s. 8d. in the first case, and with electricity supplied at 5½d. per unit is 25s. 3d. in the second case; so that the margin of profit becomes extremely small. A tariff based on rateable value scarcely meets a case of this kind; and the author therefore suggests that, where a house is let at (say) 12s. per week, a charge of £1 per annum should be made, payable monthly in advance, and the current should then be supplied at ½d. per unit. A system of this kind has the advantage that it does not stop a consumer from using electrical energy for other purposes in a small way, such, for example, as a flat-iron or kettle. With all respect to the "Electrician," we do not think such consumers are likely to make use of electrical energy in that way. The disadvantage of Mr. Barham's proposal is that a meter would be necessary; another disadvantage is that we can see some small consumers obtaining current at a lower average price per unit than other ordinary consumers for lighting in Watford. Take Mr. Fennell's figure of 100 units per annum. These at ½d. per unit would amount, with the £1 fixed charge, to £1 4s. 2d., or an average of 2·9d. per unit. These small consumers cannot pay an electricity undertaking. If they can, then the central station engineer has to face the point that the other lighting consumers are being charged far too much. From this contention, electrical engineers cannot escape.

The Industrial Committee.

When Dr. Ferranti was President of the Institution of Electrical Engineers, it will be remembered he fervently preached the gospel of a broader policy for the electrical industry; and, under his influence, an Industrial Committee was formed to look after the legislative and industrial needs and policy of the industry. Nothing much has been heard of the work (if any) that this Committee has done, nor of the good (if any) that it has effected. But it is now reported that its constitution does not enable it to do any useful work; and so we may take it that sums up its not very exciting history. The Council of the Institution, the same report says, have therefore dissolved the Committee, and so quietly buried the great hopes entertained for it at its birth.

Action of Heat and Furnace Gases on Lime-Silica Bricks.

According to an article by M. Damour, in the "Revue Métallurgique," of which an abstract translation appears in the current number of the "Journal of the Society of Chemical Industry," lime-silica bricks of the percentage composition CaO 14·1, SiO_2 78·1, H_2O + CO_2 6·8, were heated for two hours in a muffle at temperatures ranging from 100° C. to 1000° C., and the loss of weight and the strength after heating determined. The former increased with the temperature up to 550° C., when it remained practically constant; showing that at this temperature most complete decomposition of the hydrates or hydrosilicates forming the cement of the bricks took place. The crushing strength decreased comparatively slowly as the temperature increased up to 500° C.; but at higher temperatures the strength fell rapidly. At a temperature approaching that of the dissociation of calcium carbonate, the bricks fell to dust. When they were heated at 300° C. and 400° C. for varying lengths of time, and exposed directly to the muffle gases, the maximum loss in weight occurred between two and six hours' heating. Absorption of carbon dioxide thus began to take place rapidly after the third or fourth hour. After the heated bricks had been exposed to the air for several days, they regained a part of the weight lost on heating. The longer the exposure to the hot gases at a given temperature, the weaker the bricks became. Those heated to the same temperatures inside a muffle, and thus protected from the action of carbon dioxide, had an average strength nearly three times that of the bricks which had been exposed to the heating gases. The author considers that the tests demonstrate the unsuitability of lime-silica bricks for the construction of chimneys and furnaces.

Water Softening by Permutite.—This subject has lately been dealt with by Herr A. Bahrdt in "Chemische Industrie" [No. 37]; and an abstract of his article appears in the current number of the "Journal of the Society of Chemical Industry." It appears therefrom that experience at Moscow in the use of permutite for removing the hardness of water showed that sometimes there was more magnesium in the filtered water than in the untreated water, and that the reactions between the alkaline earth metals and the permutite were reversible; also that calcium could displace magnesium from the magnesium permutite previously formed. When water containing magnesia, but free from calcium, was used in a boiler, the magnesia was deposited as mud without any formation of scale. The sodium content of boiler-feed water may be allowed to increase to 5 grammes per litre without harm. Though the permutite process is simple to work and supervise, it is not necessarily the most suitable for use in every case, for with very hard waters the cost of the installation is high, and varies with the hardness; whereas in the soda-lime process the cost varies with the quantity of water to be treated. The author recommends a combination of the two processes, in which temporary hardness and most of the magnesium are first removed by lime, and then the permanent hardness, by a permutite filter. Thus a water was obtainable of very slight alkalinity, and with but little dissolved solids.

WORKS TOPICS—XXVIII.

By "Modus Operandi."

Heavy Charges and Filling of Furnaces.

The question of the size of producer suitable for works in which heavy charges are used was very briefly raised by Mr. William Wilson, of Falkirk, in his presidential address to the Informal Meeting of Scottish Gas Managers. It is quite feasible that in exceptional cases this might be a difficulty, but only in those works where the furnaces were not large enough to last four hours without being replenished, and where the settings in use contained less than seven retorts. With seven retorts to a setting, there are always three retorts in suitable positions for being discharged into the furnace. These three would be situated either all on the top row or else with two on the top row and one in the centre, commonly known as the "bull's-eye." With twelve-hour charges in use one of these three retorts can be discharged into the furnace every four hours. If the furnace is not large enough to last the four hours, either of the outside middle retorts can be used, though with some difficulty; but if this be necessary, the furnace is too shallow for the work it has to do. In the case of settings with six retorts each the difficulty is accentuated, as only the two top retorts are really suitable for charging into the furnace, so that, unless the other retorts are used, the furnace can only be filled at six-hour intervals. This is rather a long time for any but deep furnaces. Personally, I think it advantageous, even with deep furnaces, to feed them every four hours, so as to maintain a uniform quality of producer gas. Besides the fairly frequent filling of the furnaces enables the work to be done with less actual labour than is the case with furnaces charged at less frequent intervals; for the latter procedure entails more complete filling, and it is the last few hundredweights of coke that are so difficult to push into the furnace.

Mr. Wilson's warning, to the effect that the size of the producer should be carefully considered before increasing the weight and duration of the charges, is likely to be applicable to very few works. The reason of this is, of course, that any works that are large enough to adopt machinery with coke-pushers are probably large enough to have in use seven retorts, or more, to a setting. Similarly, such settings are large enough to have been fitted with furnaces able to last four hours without replenishment.

Remedies for Naphthalene Stoppages.

Very interesting indeed is Mr. Wilson's account of the effect on naphthalene stoppages of using a film of shale naphtha of ·765 sp. gr. in the gasholders and the station meter. Could not Mr. Wilson ascertain how much of this naphtha is absorbed by a definite quantity of gas at varying temperatures? It is too good an idea to be dismissed without further investigation. Perhaps Mr. Wilson would state whether any of this naphtha was found in the district syphons, as in such a case there would be waste which might not be reproduced in the case of naphtha that had been vaporized in a carburettor. It must not be overlooked that in most districts a good deal of naphthalene can be found deposited in mains and service-pipes, even though it is not actually causing stoppages. There is, however, a strong probability that at certain seasons of the year this naphthalene will be absorbed by the gas, and re-deposited at some other point where the accumulation is sufficiently bad to cause a stoppage. So that even if, with naphtha in use in gasholders and station meters, a too plentiful quantity be absorbed by the gas for carrying the naphthalene contained in the gas, the additional quantity is likely to be very effective in completely clearing the old deposits, and so save future difficulties.

Ammonia Losses.

This practical presidential address cannot be left without some reference to the sound arguments on the question of ammonia losses. Strong evidence is given to prove that a great deal of loss can be avoided by working-up the liquor as soon as possible after it is made. Ammoniacal liquor is undoubtedly very difficult to store without loss, and it is surely quite obvious that there is no possible gain in storing it. The President, indeed, shows most conclusively that a good deal of improvement may be anticipated by taking this course of action. Further, he mentions the importance of carrying liquor pipes to the bottom of the storage tank to prevent splashing and agitation of the liquor. This is very sound advice, but it is often disregarded. Quite a good hint is that of placing a film of light liquid—such as oil—on the liquor in stock, to prevent evaporation of the ammonia. The use of paraffin, as Mr. Wilson suggested, is open to objection owing to its tendency to evaporate.

Contrary to usual custom, the address was discussed. Among other points mentioned was the question of the rusting of the drums of station meters. The writer's own experience shows that this can be entirely prevented by using a film of oil on the water in these meters.

Coke versus Coal.

Mr. J. M'Nicholl, of Warrington, in his presidential address to the Manchester Junior Gas Association, gave many most useful opinions on various methods of dealing with coke on the works, and incidentally on the district as well. Those who have studied the question closely will not find it difficult to agree with every word he uttered. He compares the relative value of coke and coal slack. It is, as he states, quite erroneous to suppose that the two fuels can be compared on the basis of B.Th.U. without taking into account many other factors. For steam-raising purposes, for instance, quite a large proportion of the B.Th.U. in the slack is wasted—and necessarily so—in actual practice. It is impossible to burn the 30 per cent. of volatile matter in such coals in a boiler with any degree of success. During this crude process of distillation much heat is absorbed in the volatilization of the fuel, and in the heating of the very excessive amount of air required to complete combustion. But I will not pursue this subject. Suffice it to say that a ton of coke, unless very poor stuff, should evaporate appreciably more water in practice than a ton of coal slack.

Coke Quenching.

Mr. M'Nicholl's remarks on the relative efficiency of quenching coke with a hose-pipe and with water-sprinklers from a measured tank quite bear out my own views, already expressed in this column. All engineers should undoubtedly look closely into their own methods of coke-quenching. By means of water-sprinklers the quantity of water sprayed on the coke can be limited to a definite amount, which in practice will add a similarly definite percentage of moisture, with very little variation from day to day. With such a method, it would be quite practicable to guarantee the moisture content; but in no case could this be done with hose-quenched coke.

Washing Coke by Hand.

The hand method of washing coke referred to in the address is invariably expensive, and, to my mind, unsatisfactory. To handle 1 ton of material and only obtain 2·3 cwt. of light coke, is anything but economical. Any mechanical washer will improve vastly on such figures, and the resulting light coke will be, to all intents and purposes, as good as the hand-washed variety. As a matter of fact, the yield of light washed coke per ton of breeze treated can be greatly increased by artificially drying the screened breeze before washing. This drying has the effect of lightening the coke very considerably. By this means it is on treatment readily separated from the heavy pieces and dross. Experiments upon these lines made hand-washing commercially profitable, where before the cost of handling rendered it prohibitive. In the case in question, a small coke-fire was used to heat a special drying floor constructed of iron plates, on which the coke was laid in a 12-inch layer for twenty-four hours before being washed. The products of combustion passed underneath these plates to a chimney at the further end. As a result, the washing—which depends entirely on specific gravity—was very effective so far as the proportion of light coke was concerned.

Everyone will cordially agree that the present crude methods of quenching are urgently in need of reform; and on this account Mr. M'Nicholl's address is very opportune.

Blakeley's Patent Columnless Gasholder.

In the "American Gaslight Journal" a few weeks ago, some illustrated particulars were given of Blakeley's patent columnless gasholder, a description of which appeared some months since in the "Journal." One of the holders has been erected at the works of the Westbury (Wilts.) Gas Company, under the supervision of Mr. Norton H. Humphrys, Assoc.M.Inst.C.E., F.C.S., of Salisbury, the Company's Engineer; and in his customary letter in the issue of our contemporary for the 30th ult., he furnishes the following additional information in regard to the matter: "About a year ago, I was laying out the plans of a small 'K. & A.' water-gas set for the works at Westbury, and the inventor brought to my notice this patented system of gasholder guiding, which he offered to erect subject to a guarantee that if unsatisfactory he would add columns and girders, and convert to the ordinary pattern, at his own expense. As a practical man, there were several points about the proposition that appealed to me. When it is a question of paying as much for the patentes's royalty as the cost of the columns and girders, I have usually preferred the latter. If the wheels are adjusted once every two years, and generally attended to, the ordinary system of columns and girders takes a lot of beating. But the points that attracted my attention were that the holder rises and falls vertically, putting no side or torsional strain on the tank, and that all the wheels are at ground level, and easy of access for inspection or lubrication. These matters are of special importance for a relief holder, which gets considerably more work to do than a distributing holder, in which the make for some hours of the day runs within easy distance of the consumption. It should also be observed that wind strain is taken up by the piers, as in the ordinary construction, and is not distributed over the whole circumference of the tank wall, and therefore puts no extra strain on the top of the tank, which is necessarily the weakest part. This holder is 30 feet diameter by 12 feet high, has been in continuous operation for four months, and has proved an entire success. The extra weight of the guides on the sides seems to have a steadying effect, and there is an absolutely steady gauge under all conditions of work. I have watched the holder when nearly full, under a high wind, and there was no sign of oscillation. When on any occasion the question of a new holder comes forward, I shall certainly consider this method of construction."

"THE LANCET" ON THE MODERN GAS-FIRE AND HYGIENIC EFFICIENCY.

In "The Lancet" for Feb. 7 last two new methods were described in regard to testing the hygienic efficiency of gas-fires—a term exclusively applied by our medical contemporary to stoves which aim at supplying the energy of the combustion of coal gas in the form of radiant heat. In the article (which was reproduced in the issue of the "Journal" for Feb. 10, p. 354), it was stated that in a preliminary trial of these tests with some of the gas-fires upon the market gratifying evidence was obtained that the makers of gas-fires were steadily working towards a sound hygienic standard. Further experiments have, our contemporary remarks, confirmed this statement; and, in accordance with a promise given in the article referred to, they presented, in their issue for the 4th inst., the results of some experiments which have since been made with a number of gas-fires representing chiefly the types being offered to the public at the present time. In view of the importance of the tests carried out, we venture to reproduce *in extenso* the statements and diagrams appearing in "The Lancet."

The Shadowgraph Test and "The Lancet" Chemical Test.

We may briefly repeat a description of the tests referred to. The shadowgraph test depends on the fact that water is the principal product of combustion of coal gas. It is clear that if it can be demonstrated that water vapour from a gas-fire is issuing into the room, instead of flowing up the chimney, a defect of hygienic importance is disclosed comparable with the escape of smoke from the ordinary fireplace. Everyone knows the effect of bringing a tumbler of cold water into a moist warm air; the moisture is deposited upon the glass. This is the principle of the shadowgraph method of testing gas-fires. A piece of plate glass, called the detector plate, is carefully cooled in an ice-bath to such a point that its temperature is slightly above the dew-point of the room in which the fire is being tested. The plate is not cooled sufficiently to precipitate moisture from the normal air; but when it comes into contact with hot air surcharged with moisture, an abundant deposit takes place. Brought near to the canopy of a gas-fire which permits products of combustion to escape freely, a deposit of moisture instantly takes place, which is readily visible to the eye. But the test is made more obvious, and a record can be made, by means of a beam of light projected through the plate, when, if the stove is bye-passing water vapour from beneath its canopy into the room, a darkening (as though smoke was escaping from the stove) is seen upon the screen.

In the chemical test which was devised in "The Lancet" laboratory an absorbent pencil (such as chalk) is soaked in carbon tetrachloride, and placed near the air-inlet of the gas-fire. Traces of carbon tetrachloride are thus drawn into the burners, with the result that (on combustion) hydrochloric acid is produced which, although present in small proportion, is readily detected by coming into contact with ammonia, forming dense fumes of ammonium chloride. If, therefore, the products of combustion are bye-passing, this will instantly be shown by fumes being produced when an open tube containing strong ammonia solution, or a sponge soaked in the solution, is placed at various points along the rim of the canopy.*

Application of the Tests.

The fires were submitted to both the shadowgraph and the chemical test; and the results under each stove are recorded in parallel columns. Practically speaking, there was found to be a substantial agreement between the two sets of results, as will be seen from an inspection of the accompanying tables. In these tables the rim of the canopy of the stove is represented by a curve or straight line according to its design. There were five points at equal distances tested along this rim. The sign + indicates leakage, and the sign O no leakage of combustion products. The number of signs furnishes a relative indication of the extent of leakage. Thus ++++ means very free or excessive leakage; +++ means moderate leakage; ++ distinct leakage but slight; and + a trace (sometimes only occasional) of products of combustion escaping. In every case the tests were begun after the fire had been alight for thirty minutes, as it is obvious that the conditions necessary for the ventilation of the products through the proper outlets can only be assured when the radiating material and stove are thoroughly hot. There can be little doubt that the gas-fire presents a similar difficulty to that which is experienced with the coal fire during lighting up. Until the wood is well alight, there is frequently no draught established up the chimney, and the expedient of burning a large piece of paper during the lighting of the coal fire, in order to establish a draught and prevent the escape of smoke into the room, is well known. The fires were tested in the middle of the experimental room without any communication with the fireplace chimney. The supply of gas was kept under control so as to avoid placing an unfair demand upon the capacity of the stove under observation. All precautions were, in fact, taken to test the stoves under conditions approved by those whose business it is to instal them.

Elbows and Flues.

It will be observed in the table that the stoves were tested under four conditions: First, when there was no attachment of "elbow" to the flue nozzle of the stove; second, when there was an elbow attached; third, when a 2-feet sheet-iron flue was attached to the elbow; and fourth, when a 4-feet sheet-iron flue was attached to the elbow. An interesting differentiation was thus obtained; for if the results be carefully examined it will be found that some stoves did not require the attachment of flues at all for help in the matter of ventilation or "pull," while others failed to ventilate satisfactorily, even when a 4-feet flue had been attached. This serves to demonstrate how helpful these tests promise to be in guiding the manufacturer to design his stove so that when tested it may show negative results as regards the escape of combustion products into the room.

The Stoves Tested.

The order in which the stoves are placed in the table [on the opposite page] merely represents that in which they happened to be taken for testing purposes.

"The Lancet's" Observations.

The following are our observations as to the behaviour of each fire when submitted to the tests described. Altogether, 28 were examined.

No. 1, "No. 57" (ball-fuel) (Davis Gas-Stove Co.).—This fire gave consistently bad results. There was no relief from the escape of combustion products until a 4-feet flue was attached; and even then there was still some leakage. This is a somewhat old type of stove which is being discarded in favour of new designs by the same firm, examples of which are given further on. This firm introduced the shadowgraph test; and their recent patterns of gas-fires satisfy this test without any flue assistance.

No. 2, Renaissance (Richmond Gas-Stove Co.).—This fire is admirable in design, and, as will be seen, does not show the slightest sign of leakage of combustion products according to both the shadowgraph and chemical tests, whether it was or was not fitted with a flue or elbow.

No. 3, Stadium (John Wright and Co.).—This stove showed leakage of combustion products until a 2-feet length of flue was attached; the leakage then being very slight at the sides according to the chemical test, but not according to the shadowgraph test. Both tests, however, showed completely negative results when a 4-feet length of flue was attached. A more recent type of stove by the same makers gave quite negative results without aid from any flue or elbow (see No. 25).

No. 4, Vesta (Davis Gas-Stove Co.).—This fire gave practically negative results all through. There was, however, a slight intermittent leakage when it was tested without any attachment; but, as the results show, hygienic efficiency was completely established when only an elbow was attached. It did not require a flue length.

No. 5, Mascot (John Wright and Co.).—This fire showed profuse leakage of combustion products until a 4-feet length of flue was attached. The chemical test, it will be seen, showed greater delicacy in this experiment than the shadowgraph test.

No. 6, Apollo (Davis Gas-Stove Co.).—This fire gave satisfactory results. The chemical test showed a slight intermittent leakage when there was no aided outlet, possibly due to a slight back draught. With simply an elbow, however, there was no leakage at all.

No. 7, D.S.O. (new) (R. & A. Main).—This fire gave excellent results; there being absolutely no leakage with elbow attached.

No. 8, Pansy (Cannon Iron Foundries).—This fire gave similar results to the last; there was no sign of forward leakage after an elbow was connected.

No. 9, Jersey (Fletcher, Russell, and Co.).—This fire leaked badly without attachment, as shown by both the chemical and shadowgraph tests; but when the length of flue was 4 feet, there was no escape of combustion products.

No. 10, Rose (Cannon Iron Foundries).—This fire gave admirable results in every way. There was no sign of leakage even without an elbow attached.

No. 11, Bavarian (Richmond Gas-Stove Co).—This fire showed small leakage without the elbow attachment; but when a 2-feet length of flue was attached, there was no escape at all.

No. 12, Carlton (Wilsons and Mathiesons).—The complete ventilation of gaseous products of combustion was not effected in this fire until a 4-feet flue was attached. The same firm, however, as will be seen further on, have a fire upon the market (the Solar), evidently of an improved type, which shows practically no leakage even without an elbow attachment.

No. 13, "No. 15" (old) (Davis Gas-Stove Co.).—This is a type of stove now being discarded, for the excellent reason that its construction obviously permits the escape of combustion products, even when a 4-feet length of flue was attached.

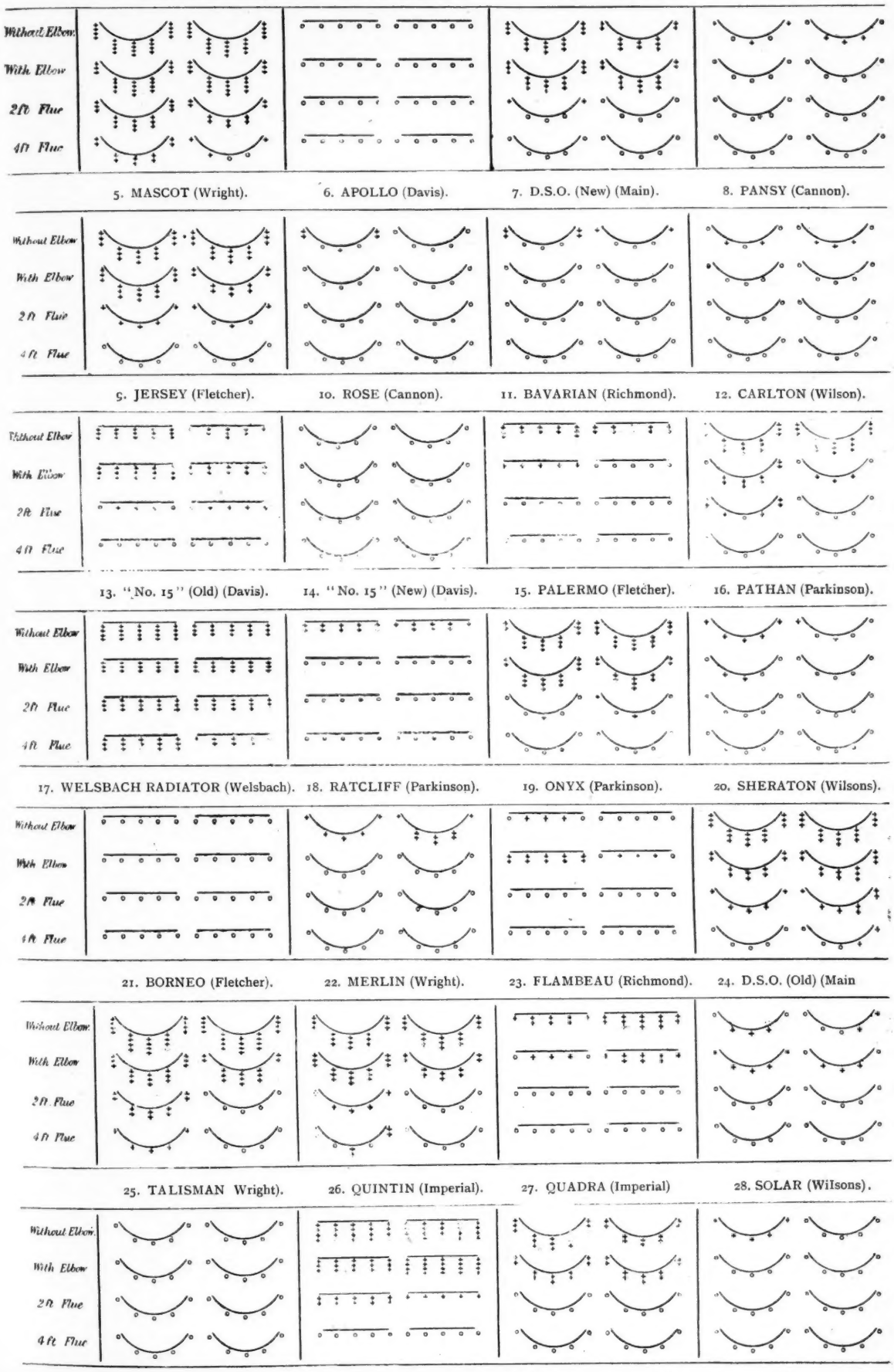
No. 14, "No. 15" (new) (Davis Gas-Stove Co.).—This is the fire which has taken the place of the previous one, and, as will be seen,

* In this connection, "The Lancet" produces "with much gratification" the cordial endorsement the test received in the course of an article on the subject in our issue of Feb. 17, where was recorded an independent experience of the test.—Ed. J.G.L.

EXAMINATION OF GAS-FIRES FOR HYGIENIC DEFECTS—See Opposite Page.

The Curves and Straight Lines represent the Rim of the Canopy of the Stove. The Sign + indicates Leakage of Combustion Products and the Sign O No Leakage.

CHEMICAL TEST.	SHADOWGRAPH TEST.	CHEMICAL TEST.	SHADOWGRAPH TEST.	CHEMICAL TEST.	SHADOWGRAPH TEST.	CHEMICAL TEST.	SHADOWGRAPH TEST.
1. "No 57" (Ball fuel) (Davis).		2. RENAISSANCE (Richmond).		3. STADIUM (Wright).		4. VESTA (Davis).	
5. MASCOT (Wright).		6. APOLLO (Davis).		7. D.S.O. (New) (Main).		8. PANSY (Cannon).	
9. JERSEY (Fletcher).		10. ROSE (Cannon).		11. BAVARIAN (Richmond).		12. CARLTON (Wilson).	
13. "No. 15" (Old) (Davis).		14. "No. 15" (New) (Davis).		15. PALERMO (Fletcher).		16. PATHAN (Parkinson).	
17. WELSBACH RADIATOR (Welsbach).		18. RATCLIFF (Parkinson).		19. ONYX (Parkinson).		20. SHERATON (Wilsons).	
21. BORNEO (Fletcher).		22. MERLIN (Wright).		23. FLAMBEAU (Richmond).		24. D.S.O. (Old) (Main	
25. TALISMAN Wright).		26. QUINTIN (Imperial).		27. QUADRA (Imperial)		28. SOLAR (Wilsons).	



works entirely differently and in satisfactory hygienic direction. There was no leakage at all of combustion products when an elbow was attached.

No. 15, PALERMO (Fletcher, Russell, and Co.).—This fire showed abundant leakage when tested without an elbow attachment. There was no improvement with the elbow; but when a 2-feet length of flue was attached, the escape was very decidedly reduced, while with a 4-feet flue there was no escape at all.

No. 16, PATHAN (Parkinson Stove Co.).—This fire showed no serious leakage even without the elbow, and with it the ventilation of the combustion was established. With a 2-feet length of flue there was no sign of leakage.

No. 17, WELSBACH RADIATOR (Welsbach Light Co.) —This fire showed negative results as regards the escape of combustion products. They passed completely out of the flue-nozzle, even without an elbow attached.

No. 18, RATCLIFF (Parkinson Stove Co.).—This fire is evidently constructed on right lines so far as hygienic efficiency is concerned. It showed a trifling leakage when the work of ventilation was entrusted to the flue-nozzle; but on connecting the elbow, there was no bye-passing of combustion products at all.

No. 19, ONYX (Parkinson Stove Co.).—This fire is by the same makers as the previous one, but is of different design—the run of the canopy being in a straight line. There was slight leakage with the elbow attached; but on adding to this a 2-feet length of flue the products of combustion escaped completely through the proper channel. When an elbow of a different shape was attached, there was no leakage even without a 2-feet flue.

No. 20, SHERATON (Wilsons and Mathiesons).—This fire showed considerable escape of combustion products in front of the canopy until an elbow was attached and a 4-feet flue.

No. 21, BORNEO (Fletcher, Russell, and Co.).—This fire leaked badly with the elbow attached, but showed some improvement when a 2-feet length of flue was added. Even with a 4-feet flue attached there were intermittent escapes of combustion products.

No. 22, MERLIN (John Wright and Co.).—This fire only commenced to show good results when a 2-feet length of flue was attached. Even when a 4-feet flue was attached, there were occasional signs of small escape.

No. 23, FLAMBEAU (Richmond Gas-Stove Co.).—This fire without an elbow attached to the flue-nozzle showed some leakage. There was an improvement when the elbow was supplied; and with the addition of a 2-feet flue there was no leakage at all.

No. 24, D.S.O. (old) (R. & A. Main).—This fire has been improved upon. It bears the same name as No. 7 in the table, which showed practically no serious leakage, even without an attachment. No. 24 shows some leakage with an elbow which entirely disappears when a 2-feet length of flue is attached.

No. 25, TALISMAN (John Wright and Co.).—This fire gave negative results as regards the bye-passing of products of combustion under all the conditions of testing. Even without an elbow, there were no signs of products of combustion escaping forward from beneath the canopy.

No. 26, QUINTIN (Imperial Gas-Stove Co.).—This fire showed a bad leakage of combustion products without an elbow, and matters did not improve very much when an elbow was attached. There was an improvement when a 2-feet flue was connected; and there was no bye-passing at all when the flue was 4-feet long.

No. 27, QUADRA (Imperial Gas-Stove Co.).—With its flue-nozzle only as a means of outlet, there was decided escape of combustion products from this fire from the canopy into the room. Not until a 2-feet flue was attached did this bye-passing cease.

No. 28, SOLAR (Wilsons and Mathiesons).—This fire worked well without any flue provision. There were just traces of combustion products escaping when there was no elbow. These were not shown by the shadowgraph. The moment the elbow was attached, the fire worked admirably; the testing showing no trace of escape from beneath the canopy in the room.

Of twenty-eight gas-fires examined, four gave no evidence of the escape of combustion products when only the flue nozzle was left to do the effluent work; seven fires, while not working favourably under these severe conditions, did not allow products of combustion to escape when an elbow supplied with the gas-fire was attached; eight fires showed a leakage under these conditions, but they proved to work satisfactorily when an elbow and 2-feet length of flue were attached before the escape of combustion products was stopped; five fires showed no leakage with a 4-feet flue attached; and the remaining four still allowed products of combustion to escape with a 4-feet length of flue attached. It should be said, however, that the escape in many instances was so slight as to be without hygienic significance. The chemical test is a very delicate one.

Is Hygienic Efficiency Opposed to Heating Efficiency?

It may be urged that hygienic efficiency can be secured easily enough, but at the expense of heating efficiency. It should be remembered, however, that we are dealing with fires which are claimed to give chiefly radiant heat. The effect of a "pull" on actual radiations need not be serious. Radiations from the sun obviously travel through cold currents of air without much disturbance; and these heat radiations can be focussed through an ice lens. On heat currents the effect of a strong draught would be marked. After all, the public may be trusted to decide whether a gas-fire is an efficient warmer for the purpose; and a stove would naturally soon be rejected if it failed in this respect. When the householder receives an assurance that a stove is hygienically efficient, he will soon be able to satisfy himself whether the efficiency is coupled with heating efficiency. If the room is not comfortably warmed in a reasonable time, and a generous warmth is not kept up, it is time to ask what is the good of a healthy stove if it does not keep the place warm.

This question bears obviously also on the question of the economy of gas for domestic heating purposes. It is now fairly well agreed that one important reason why heating by gas has increased in favour is that the makers of gas-stoves have been actuated by the view which we have for long endorsed—that radiant heat is hygienically the best. They have accordingly striven to utilize as much as possible the calorific value of coal gas in terms of radiant efficiency. In other words, their model now is in reality the hot radiant coal fire, which is instrumental in two directions. Firstly, it warms the living room by means of its exclusively radiant heat; and, secondly, it provides a shaft which effects an important amount of ventilation. The gas-fire should do the same. The combustion of coal, however, is always imperfect, and therefore wasteful and offensive; the combustion of gas is complete, and therefore economical and inoffensive. It is a manifest advance in domestic methods of heating by gas that the modern gas-fire can now provide a radiant efficiency of from 50 to 60 per cent. We attach some importance to this step from economic considerations; but we attach far more importance to it when we know that this position can be gained with hygienic security.

After all, the demand that a gas-stove shall furnish only radiant heat implies (except for the heat communicated by its canopy and casing) that it shall not allow products of combustion to escape into the room. The stove which permits this leakage will, of course, show a higher general heating efficiency due to the circulation of hot gases of combustion—a process of heating by convection currents. This means, however, the pouring into the dwelling room of hot water vapour and carbonic acid gas, to which objection must be taken on the ground that a strong physical, although only a slight chemical, vitiation of the air results, which may soon lead to oppression and discomfort.

Some Points in Construction.

It is not in our province to discuss the construction of gas-fires which will meet equally the considerations of both heating and hygienic efficiency. This may well be left to the gas-fire constructor, with the help afforded him in this matter by the lessons of the new simple tests. During these experiments, however, certain observations were made, which indicate some directions in which structural alterations might be made with hygienic gains. In some cases, for example, it was discovered that the only defect in the gas-fire was the shape of the flue-nozzle. The flue-elbow supplied in some cases was elliptical in shape at the end where it is attached to the stove, but cylindrical at its exit. This elbow occasionally offered resistance to the passage of the flue gases, and so an escape appeared at the canopy. But when the elbow was replaced by one which was elliptical throughout (end to end) the tests indicated no leakage whatever. The experience generally was that the broad elliptical flue gave the best results, whereas invariably the cylindrical flue seemed to be inadequate for completely carrying off the gases of combustion. We regard this as an important point; and it must be remembered that, while one shaped flue will suit one kind of gas-fire, it may be utterly unsuited to another type. There should be no mixing-up of flue-elbows; and it is important that when a stove is placed in position it should have attached to it the flue-elbow which gives satisfactory working results. In some cases there was supplied a flue-elbow which caused a leakage of combustion gases at the canopy, which was soon remedied by attaching an elbow of another shape. There should be no excuse for supplying a flue-elbow which is opposed to satisfactory working conditions when these can be readily shown by simple tests. Attention to the details of construction of the stove itself must not be accompanied with neglect of such points.

One of the most important advances made in gas-fire construction was when "ball fuel" was discarded in favour of the radiating tube. In "The Lancet" Commission upon the subject, as far back as the year 1893, this defect was pointed out as one of the sources of incomplete combustion, and oftentimes of disagreeable smells. Nevertheless, the "dressing" of a gas-fire still needs attention. Some gas-fires, for example (as an inspection of the table will show) worked satisfactorily except for a small escape of combustion products at the sides of the canopy. This was remedied in some cases by taking out the distal tubes each side, and in others by removing the cross "dressing" (where this was used) on the top of the tubes. According to this it would be an advantage to leave a gap between the side of the stove and the last radiating tubes, and to modify the cross top-dressing which is probably only used to give a finished appearance to the stove. The construction of the canopy and the point whether the tubes should project into it, or whether an open space should be left between, have been freely discussed by the gas-fire industry, and there appears to be considerable difference of opinion on this question. But the chances of solving such problems are very much improved by the convenience of application offered by simple testing. One of the defects of a gas-fire—the irritating purring noise of the burner—is receiving the attention of makers with some success.

Another important question already alluded to is that of flue capacity. It will be noted that some fires work satisfactorily, hygienically speaking, without the aid of a flue, while others allow an escape of products of combustion from under the canopy unless they are fitted with certain flue lengths. The question is narrowed if we accept that the flue is part of the outfit of a gas-fire. It may be contended that it need not be. We agree that it is not essential; for it is obvious that fires are constructed which

do not require a flue, and yet do not allow gaseous products of combustion to escape from the canopy into the room. It is entirely a matter of design. The stove can be designed to work with or without a flue. There appears to be no difficulty about constructing it to meet either case. The limit of safety is reached, possibly, when the flue required to give the necessary "pull" is inconveniently long, so that there would be difficulty in placing it in the chimney.

General Considerations.

From the hygienic point of view, which in the present article is our only consideration, it matters little whether a stove works in the open without or with an auxiliary "pull," so long as, when it is set in its place of practical duty, it shows no leakage of combustion products. Although a fire may fail unattached to ventilate itself automatically, it may work perfectly well when it receives a chimney pull which may equal anything from that of a 6-feet to a 16-feet flue-pipe. On the other hand, if by reason of an attained high standard of hygienic efficiency it loses heating efficiency, the system breaks down on economic considerations. It is quite obvious that the maximum heating effect of coal gas can be obtained by burning it in the open room with no outlet at all for the products of combustion. The process of heating is then purely by convection—the circulation of heated air currents; there is no radiation at all. The attractive feature of the modern gas-fire is, as we have said, that 50 to 60 per cent. of the heating value of the gas which it consumes is made radiant, which is exclusively the form of heat given by the coal-fire. Radiant heat is acknowledged to be the most cheerful and healthful agency for keeping our dwelling rooms comfortable and warm; and the modern object of the makers of gas-fires is (in our view very rightly) to render the heat of combustion of the gas in this form. In this they have met with considerable success; and further advances in this direction will most likely be made and a yet greater proportion of the calorific value of coal gas become available as radiant heat.

If the correct consummation of the application of gaseous fuel to domestic heating purposes is a maximum radiating efficiency, the question of whether a stove should be required automatically to ventilate itself without the services of a flue-pipe to convey away the products of combustion diminishes in importance, since the effect of a reasonable "pull" short of a blast is negligible. At the same time, the view that a stove should show no leakage of combustion products without the aid of a flue should not be discouraged; for it discloses a keen regard for hygienic conditions.

Question of Standard.

As the result of our experiments, we are inclined to express doubt whether a stove should be accepted for service which, on testing, shows a leakage of combustion products when a flue has to be attached exceeding 4 feet in length. It will be observed in the table that certain of the fires showed marked leakage even when a 4-feet flue was attached. In our opinion these stoves fail to pass a desirable standard of hygienic efficiency. They cannot at any rate be compared with others in the list which gave absolutely blank results without a flue at all. It is fair to add that certain of the stoves which showed leakage under the extreme conditions laid down were not the very latest types; and we know that these are rapidly being replaced by improved designs which completely satisfy "The Lancet" test.

There are, of course, gas-fires upon the market which have escaped our notice; but we believe we have included the majority of those now being supplied to the public. Any omissions we may have made we shall be glad to repair in a subsequent article if the makers will communicate with us, and we are willing to submit to test any new designs which are claimed to be an advance on existing types.

We believe the movement to bring gas methods of domestic heating into acceptance, from both a hygienic and economical point of view, is of considerable importance in the public interest, and we therefore support it. Gas-stove makers can study the tests for themselves, and model the construction of gas-fires so as to pass certain requirements. If this is consistently done, and acted upon, no reproach against the radiant system of gas heating will remain.

We conclude that the final appeal in this matter must be to the chimney and fireplace when the gas-fire is placed there for practical duty; and the tests can just as easily be conducted in the house as in the factory. In our opinion, a logical standard of hygienic efficiency cannot be set up without reference to the considerations we have brought forward. The present attitude of the gas-fire industry towards all questions of improvement is a most satisfactory one; and our inquiry shows that we may fairly expect in the near future an encouraging and hopeful issue.

A New Gas Indicator.—A gas-testing apparatus has been designed by Mr. A. Williams, an electrical chemist, for enabling the presence of explosive gas underground to be detected and registered, even to one-tenth of 1 per cent. In addition the instrument rings a bell, so as to give an alarm to the workmen. Mr. Williams explained his invention to the Miners' Conference in London last week, and made several experiments with mine gas brought from a South Wales colliery for the purpose. In each case the instrument set the bell ringing immediately it was brought in contact with the gas.

THE PATENT OFFICE REPORT.

Though the trend of invention is constantly changing, as fashions do, invention itself, in one direction or another, is always going on; and the Patent Office is a Government Department which is never out of favour. This is shown by each successive annual report of the Comptroller-General of Patents, Designs, and Trade Marks. The thirty-first of this series of documents (dealing with 1913) was published a few days ago, over the signature of Mr. W. Temple Franks; and the tale it tells is one of steady work.

Problems in connection with locomotion constituted the principal direction in which inventors turned their attention last year; many of the suggestions relating to details of motor-cars. Aeronautics still provide subject-matter for inventors; and there has been a well-marked increase in proposals relating to internal-combustion engines for these and other purposes. In the oil industry, we learn, a lively interest is still being shown in methods of converting heavy hydrocarbon oils into motor-spirit; and considerable work has also been done in the distillation of carbonaceous substances at low temperatures for the production of similar light oils. Then, in the field of advertising, special attention has been given to the development and perfecting of apparatus for effecting a selective and intermittent exposure of signs and announcements. The crop of fatal railway collisions led to a large number of applications in regard to automatic or partly automatic devices for signalling or for stopping trains. Perhaps a small matter, but one that will be of interest to travellers in the country, is the announcement that attention has been given to the improvement of direction-posts for roads.

Glancing at the figures to see how the business of 1913 compares with that of the immediately preceding year, it is found that the number of applications for patents in the period under review (30,077) was practically the same as in 1912, and considerably more than in 1911—the two years' figures were respectively 30,089 and 29,353. The applications accompanied by provisional specifications fell from 19,825 in 1912 to 19,673, which was a decrease of 0·8 per cent.; while those accompanied by complete specifications rose from 10,264 to 10,404, or an increase of 1·4 per cent., and the highest number on record for any one year. This made the number of applications, as already remarked, 30,077, or within twelve of the number for the preceding year. The complete specifications filed on previous provisionals rose from 8589 to 8905, which was an increase of 3·7 per cent. Thus the total number of complete specifications received was 19,309, compared with 18,853, or an increase of 2·4 per cent., and again the largest number on record for any single year. The proportion of complete to provisional specifications filed on application, as a matter of fact, is continuing its general tendency to increase; the figure being nearly 53 per cent. in 1913, compared with 52 per cent. in 1912. The total number of specifications, provisional and complete, received last year was 38,982, or an increase of 0·8 per cent. Less than 500 of the total applications were from women.

Of all the applications, 18,913 came from residents in England and Wales, 1131 from Scotland, and 363 from Ireland. There was an increase in the applications received from England and Wales, India, the South African Union, and Belgium; and a decrease in those from the Australian Commonwealth, New Zealand, Austria, and the United States. The applications from Germany numbered 3167, compared with 3169 in 1912; from the United States, 2646, against 2986; and from France, 1143, against 1097. Out of 12,833 patents sealed upon the applications made in the year 1900, 508, or 4 per cent., were maintained for the full period of fourteen years. The number of patents which expired in 1913 was 15,356; and the total number of new patents sealed was 16,599. Thus the number of patents in force was increased during the year by 1243.

The table indicating the result of the examination of the complete specifications filed on applications made in the year 1912, shows that 1174 of the specifications were reported as wholly anticipated, 10,903 as partly anticipated, and 5330 as not anticipated. Of those that were anticipated, 11,003 were amended without a hearing taking place, and 650 after a hearing and decision. In 311 cases, a reference to a previous specification was inserted. The Comptroller is empowered to revoke a patent upon application made within two years of the date of the patent by any person who would have been entitled to oppose its grant; and there were nine such applications. In three cases the patent was revoked (in one of them by consent); and in one an order was made requiring an amendment of the patentee's specification. Four applications were dismissed; the remaining one was withdrawn. The number of applications made for the revocation of patents worked exclusively or mainly outside the United Kingdom was eight. In one of these the patent was revoked by consent; and in seven of them the applications for revocation were withdrawn. During last year three petitions for the extension of term of patents were lodged. One was abandoned, and another is still undecided. In the remaining case the term of the patent was extended for five years. There are now three patents in force which have been prolonged beyond fourteen years.

From the classification of published complete specifications for 1912 (the figures for 1913 are not included), it is seen that 1045 related to internal combustion engines, 133 to compressing air and gas, 78 to treating air and gas, 42 to gas distribution, 71 to coking, &c., 139 to gas manufacture, and 208 to burners.

The receipts from patents fees last year were £307,054, as

compared with £293,529 in 1912; from designs fees, £8166, against £7891; from trade marks fees, £17,742, against £19,359. The receipts from sales of publications amounted to £13,352—making the total receipts £346,324, as compared with £333,467 for the preceding year, or an increase of £12,857. The expenditure—which was £194,423, compared with £201,840—shows a decrease of £7417.

EVENT AND COMMENT.

[Communicated.]

Much interest has been aroused recently in Glasgow on the question of working-up the bye-products from the gas-works. At present a portion at any rate of these bye-products is sold to an outside firm, who work them up as required. It is contended in certain quarters that it would better pay the Corporation of Glasgow to deal with the bye-products themselves rather than dispose of them to an outside firm. A letter appeared in the correspondence columns of a Glasgow paper the other evening in which the writer urged the desirability of the Corporation taking on the work, and purporting to show that they would gain considerably thereby. Now this opens up a very important question—viz., the extent to which municipal trading should go. The argument in favour of it is that, if it pays the private trader to buy up the products and work them, it also ought to pay the Corporation equally well to work the products. On the other hand, less capital expenditure is required by making use of outsiders; there is less responsibility; and also the outsiders have in many instances better facilities for disposing of the ultimate products. This latter argument applies especially in the case of small works. Where the make of gas is under about a million cubic feet per day, it is probably more satisfactory in the end to introduce the outsider. In the case of large works generally, it should be to the advantage of the works to deal with their own residuals provided they can fully employ an up-to-date plant.

The tendency nowadays is certainly towards the adoption of the direct recovery process on gas-works. If, as one may reasonably expect, this is generally adopted, the problem referred to above will practically solve itself, as in such case the ammonia would be recovered in the form of sulphate on the works. It has to be remembered, however, that a quantity of the ammoniacal liquor which is produced is converted into strong ammonia, and that to do this from sulphate would be both an expensive and a roundabout proceeding.

While on the subject of direct ammonia recovery, it is interesting to review the pros and cons of its adoption on gas-works. It is already in operation at a few large works on the Continent, and on some small works in this country. At many coke-oven plants on the Continent, part of the gas is supplied for town purposes; and this gas is treated by the direct process. It seems to give satisfaction; and it is said that as far as the gas is concerned, there is no deleterious effect on either its illuminating power or its calorific value, by passing it through sulphuric acid. Those responsible for this statement are all gentlemen connected with the bye-product coking industry; and it would no doubt give encouragement to the gas industry if some well-known gas engineer would take upon himself the duty of an independent investigation. It would not be a very troublesome matter, and the result would have a far-reaching effect. It is admitted that the present method of ammonia recovery is by no means perfect; and that far better yields would be obtained by the adoption of the direct-recovery process. The amount of liquor to be dealt with is reduced almost to zero; as also is the troublesome effluent. The process is much more continuous and automatic, and the salt produced is generally much better in appearance than the usual gas-works sulphate. It has to be remembered, however, that by the abolition of the scrubbers, so also is abolished the purifying value of the ammoniacal liquor. This is often placed at from 30 to 50 per cent. of the total purification requirements; so that in most cases extra boxes would have to be put on. The increased cost should not, however, be very much; and it would probably be balanced by the increased yield of ammonia, the saving in lime, steam, &c.

German Coal in England.

The report that a large contract for German coal had been placed by a British gas company created widespread interest, and aroused much feeling on the question of supporting home industries. Nowadays, however, very few businesses will allow of the confining of buying operations to the home markets, irrespective of price; and when one considers the attitude of colliery owners with regard to gas-coal contracts, it is not surprising to find buyers looking abroad for supplies. But we must not throw the whole blame upon colliery owners; how far are the miners themselves responsible for the state of affairs? From reports issued recently one finds that of the three greatest coal producing countries—viz., the United States of America, the United Kingdom, and Germany—the production per head of the miners is least in the United Kingdom. To some extent, therefore, this explains the difference in price in the three countries. From a sentimental or patriotic standpoint, there can be little or no objection to the importation of German coal. We are competitors with Germany in the principal markets of the world; we use an infinite variety of German products in this country; we supply Germany with numerous products; and we export large quantities of coal every year to German gas-works. From the strike point of view, it certainly seems that we have reached such a pitch in this country that we must have strikes at very frequent intervals—thereby necessitating the holding of large stocks of coal or risking stoppages. On the Continent—although labour troubles are by no means unknown—there does not seem to be the sense of uncertainty which is so often present with us. Consequently, there may be a feeling among buyers that they are better able to depend upon supplies from Germany than from this country in case of trouble. There is, however, always the possibility of sympathetic strikes; and, in the event of trouble, it is not at all unlikely that matters would be still further complicated by the refusal of men to handle what they would probably term "blackleg material."

Liquid Purification.

The question of liquid purification is likely to be again brought to the front in the near future. The experiments on this subject by Dr. W. B. Davidson, of Birmingham, are being watched with interest by many gas engineers; and there seems little doubt that eventually Dr. Davidson will evolve a process which will be quite satisfactory from the gas engineer's point of view. In the Birmingham process, however, the question of purification is the main one involved; and little if any concern is shown with regard to the ultimate products. On the other hand, there are the Feld and Burkheiser processes with the two-fold object of purification and the manufacture of sulphate of ammonia—the latter being if anything the predominating feature. At the present time it cannot be said that either of these processes is a full commercial success, although the Feld process is now in operation at two or three Continental works. The recent death of the patentee, Herr Walther Feld, who personally took responsible charge of the working of his process, may tend to somewhat stop the development; but the writer is of the opinion that in the next decade a satisfactory process will be brought out. With the present processes, efficient technical and scientific supervision is necessary; and there are too many fine points for the ordinary workman to watch. Undoubtedly good results have been obtained with these processes; but only under such supervision as it would be impossible to give in ordinary working circumstances. The latest development of the Burkheiser process is a combination of the original process with the so-called direct ammonia recovery process.

Are Horizontals Obsolete?

All modern systems of carbonization—such as vertical retorts, horizontal and inclined chambers, &c.—are urged for adoption principally on account of the advantages they claim to possess as gas-making appliances. Their capital cost is invariably higher than that of horizontal retorts; but the labour costs are considerably reduced. Vertical retorts have received high praise in many quarters during the last few years; but there are still a few places—Sheffield, for example—where horizontals with machine stoking can at least hold their own. It was interesting to hear in Mr. F. G. Pearce's paper before the London and Southern Juniors a little while ago of the excellent results obtained at the North Middlesex Gas Company's works. In this case with a remodelled plant of horizontal retorts operated by a Fiddes-Aldridge machine the high yield of 14,000 cubic feet of gas per ton of coal was obtained. It is at the same time astonishing to read that this represents an increase of 2400 feet per ton of coal. One may wonder what induced the Company to refrain from scrapping the old plant years ago. As a contrast to the cry in many quarters still for 16 to 18 candle gas, in this instance it is only 13·17 candles by the No. 2 burner! One of the objections against verticals and chamber ovens has been the low candle power of the gas produced. Perhaps the most remarkable statement, however, is that the fuel consumption with the new settings, over a period of five months, was only 10·1 per cent.! This figure is almost unheard of for horizontal retorts, and indeed is better than most for either verticals or chambers. After the experience of North Middlesex Gas Company, who shall say that the day of horizontal retorts is gone for ever?

Earthen Water-Works Embankments.—At a students' meeting of the Institution of Civil Engineers held on the 3rd inst. (Mr. Edward Sandeman, M.Inst.C.E., in the chair) a paper was read on the "East Stirlingshire Water-Works and a Note on Earthern Embankments," by Mr. Oswald Irving Bell. The first part of the paper consisted of a description of the methods employed in the construction of the water-works supplying the eastern district of the county of Stirling. It was accompanied by a number of very interesting slides, which were explained by the author in the course of his reading. The second part of the paper dealt with the design and construction of earthern embankments employed for impounding water, and was illustrated by diagrams. The discussion was opened by Mr. W. C. Mitchell, and continued by Messrs. D. A. Stephens, F. R. Freeman, W. H. Cooper, P. V. Hoare, P. J. Bowie, and H. E. Denny. The author, in his reply, dealt at length with the various points raised in the discussion, and the Chairman made some remarks on the design and construction of the puddle wall in earthen embankments.

INDUSTRIAL GAS CALORIMETRY.

By C. W. Waidner and E. F. Mueller.

We have received from Mr. S. W. Stratton, the Director of the Department of Commerce of the Bureau of Standards at Washington, an interesting *résumé* of a lengthy paper, on "Industrial Gas Calorimetry," prepared by Messrs. C. W. Waidner and E. F. Mueller. The complete paper is the result of an investigation (carried out during the past two years in the laboratories of the Bureau of Standards, as time has permitted) into various forms of calorimeters used in the gas industry, sources of error to which these instruments are liable, the precautions to be observed, and the accuracy attainable, in their use, &c. The complete results of the investigation have now been brought together; and it is intended shortly to publish what promises to be a very complete study of the subject. Recognizing that the paper in its complete form would be too lengthy for publication in current technical literature, the authors have prepared a very much abbreviated abstract, embodying the more important conclusions of their investigations. It is a copy of this abstract that Mr. Stratton has been good enough send—rightly thinking that it would be of sufficient interest for publication in the "Journal."

In a "Technologic Paper" entitled "Industrial Gas Calorimetry" are given the results of an experimental investigation of some of the types of gas-calorimeters that have been most widely used in the United States and abroad for the determination of the heating values of gases. The investigation was carried out in order to furnish to gas engineers, public service commissions, and gas inspectors exact information as to the accuracy attainable with the instruments, the sources of error to which they are liable, and the important precautions that should be observed in their use in order to obtain reliable results. The instruments included in the investigation were the Junkers (original type), Hinman-Junkers, Sargent, Junkers (new type), Simmance-Abady (English type), Boys, Simmance-Abady (American type), and Doherty calorimeters, all of the flow type, and the Parr calorimeter of the comparison type.

As the original paper contains about 125 pages and 70 tables and illustrations, a brief *resumé* of the results is presented here in order to facilitate use of the material by those interested in the conclusions.

After a consideration of the heat units, in terms of which the heating values of gases are expressed, and of the definitions of the term "heat of combustion of a gas," the following definitions of the heats of combustion of a gas are used as being sufficiently precise for engineering and industrial purposes.

Total Heating Value and Net Heating Value.

The total heating value of a gas, expressed in the English system of units, is the number of British thermal units produced by the combustion, at constant pressure, of the amount of the gas which would occupy a volume of one cubic foot at a temperature of 60° Fahr., if saturated with water vapour and under a pressure equivalent to that of 30 inches of mercury at 32° Fahr., and under standard gravity, with air of the same temperature and pressure as the gas, when the products of combustion are cooled to the initial temperature of gas and air, and when the water formed by combustion is condensed to the liquid state.

The net heating value of a gas, expressed in the English system of units, is the number of British thermal units produced by the combustion, at constant pressure, of the amount of the gas which would occupy a volume of one cubic foot at a temperature of 60° Fahr., if saturated with water vapour and under a pressure equivalent to that of 30 inches of mercury at 32° Fahr., and under standard gravity, with air of the same temperature and pressure as the gas, when the products of combustion are cooled to the initial temperature of gas and air, and the water formed by combustion remains in the state of vapour.

According to the above definitions, the net heating value is less than the total heating value by an amount of heat equal to the latent heat of vaporization, at the initial temperature of the gas and air, of the water formed by the combustion of the gas.

For most calorimetric calculations, the heat of vaporization of water may be taken as being equal to 580 calories per gramme, corresponding to 2·3 B.Th.U. per c.c.

Observed Heating Value.

In addition to the terms total heating value and net heating value, the term observed heating value will be used as a matter of convenience in discussing the experimental data. The observed heating value for a flow calorimeter will be understood to be the value obtained by multiplying the mass of water which flowed through the calorimeter during the test by the corrected rise in temperature of the water, and dividing by the volume (referred to standard conditions of 60° Fahr. and 30 inches) of gas burned.

The observed heating value will, under the usual conditions of operation, be less than the total heating value, on account of various heat losses which are considered in later sections of the paper; this difference amounting to several per cent. for some of the calorimeters tested, and to 2 per cent. or more for all the calorimeters under some conditions of atmospheric temperature and humidity. The types of calorimeters that have been used to measure the heats of combustion of gases are briefly reviewed, and the fundamental principles of flow calorimetry are explained, with an example showing all the observations, corrections, and calculations necessary to find the total and net heating values of a gas with a flow calorimeter.

After a description of the construction and mode of operation of laboratory meters and of their preparation for and method of use, there are given in the full paper the results of experimental investigations of the sources of error in the calibration and use of such meters. The importance of levelling the meter, and of the careful adjustment of the water level in the meter to the gauge mark, is emphasized, since, in order to reproduce the calibration of the meter from time to time to an accuracy of $\frac{1}{4}$ per cent., the total error in adjusting the water content of the meter, whether the error is due to error in levelling or in adjusting the water level to the gauge mark, must not exceed the equivalent of 0·01 or 0·02 inch in the position of the water level in the gauge glass. The calibration of the meters was found to be independent of the rate (to within 0·1 per cent.) for rates of 2 to 10 cubic feet per hour. At 20 cubic feet per hour the meters were slightly slow (about 0·5 per cent.).

The use of fractional turns of the meter may lead to significant errors—*e.g.*, in one of the most smooth running meters tested, the amount of gas delivered in the last one-third revolution was about 8 per cent. less than in the first one-third revolution. If fractional turns are used, the dial should be calibrated by the method given in the paper. The results of calibrations of the same meter by different methods show an agreement of the order of 0·1 per cent. It was found that the method of calibration by the standardized bottle, in which the meter is started from rest and again brought to rest, gave a calibration correct to within 0·1 per cent. for use in calorimetry, in which the volume of gas delivered between successive passages of the index through zero is measured. The accuracy attained with these meters in the measurement of the volume of gas burned in a heating-value test was of the order of 0·2 per cent. when the meter was calibrated *in situ* at the time of use, and of the order of 0·5 per cent. when a careful calibration, once made, was afterwards reproduced by making the necessary adjustments.

In Section VII. of the paper is given a large amount of experimental data on the various factors that may affect the accuracy of the heating-value determinations with flow calorimeters. The summarized conclusions relating to these factors (sixteen in number) are given, so far as is possible within a limited compass.

I.—Completeness of Combustion.

Numerous experiments, in which the character of the bunsen flame was varied from a strongly oxidizing to a partly luminous condition, indicated that the combustion of illuminating gas and natural gas was quite complete (within 0·2 per cent. at least) in the bunsen burner. There is little probability of significant error due to incomplete combustion, if the calorimeter is not operated at too high a rate of gas consumption.

II.—Temperature Measurements.

By the use of suitable thermometers, graduated to 0·1° or 0·2°, carefully standardized to determine their corrections, and read so as to avoid errors of parallax, with the necessary corrections (including the emergent stem correction) applied to the observed readings, and with a suitable mixing device to ensure that the bulb of the outlet-water thermometer is at the true mean temperature of the effluent stream of water, the temperature rise of the water flowing through the calorimeter may be measured with an accuracy of 0·04° or better, corresponding to about 1·3 B.Th.U. in a test of a 600 B.Th.U. gas, when the rise of temperature measured is 18° Fahr. The efficiency of the mixing device may be tested by taking a series of readings of the outlet-water thermometer (when the calorimeter is in operation and conditions are steady) with its bulb in different positions in the effluent stream, and thus determining whether the thermometer indicates the same average temperature in all positions.

The inlet and outlet water thermometers, even if once carefully tested and certified, should be tested by the user at intervals of some months for any relative changes in their indications with the lapse of time. In the subsequent use of the thermometers, a so-called differential correction, to allow for this relative change, should be applied to the readings of one of the thermometers (preferably the outlet-water thermometer) in addition to the corrections given in the certificates.

The correction for the emergent stem of the thermometer may be computed from the formula:

Stem correction in degrees Fahrenheit $0{\cdot}000085 \times n \times (T^0 - t^0)$ when n = number of degrees emergent from bath.

T = temperature of bath.

t = mean temperature of emergent stem.

If the water enters the calorimeter at, or very nearly at, room temperature, the emergent stem correction to the inlet-water thermometer will be entirely negligible. Under some conditions —*e.g.*, high room temperature and n large—the stem correction to the outlet-water thermometer may attain nearly 0·1° Fahr.; so that neglecting the stem correction would cause an error in a heating-value test amounting to approximately 0·5 per cent.—*i.e.*, 3 B.Th.U. in 600 B.Th.U. gas. Air entrapped in the calorimeter should be removed, as it causes fluctuations in the rate of water flow, and hence in the readings of the outlet-water thermometer. A sudden drop in the temperature of the inlet water will result in giving an observed heating value that is too high, and a sudden rise a value that is too low. Observations in which the temperature of the inlet water varies by more than a few hundredths of a degree during the time of a single determination of the heating value should be rejected.

The method used by Immenkötter, of reading the inlet-water thermometer earlier than the outlet-water thermometer by the length of time required for the water to pass through the calorimeter, largely eliminates errors due to variations in the inlet-water temperature, and is therefore to be preferred, especially if the inlet-water temperature is not sufficiently constant. An error of 1° Fahr. in the measurement of the temperature of the gas in the meter causes an error of about 0·3 per cent. in the resulting heating value. An error of 1° Fahr. in the determination of the room temperature would not lead to an error in the resulting heating value exceeding 0·1 per cent., except under very unusual conditions. In the determination of the room temperature in the neighbourhood of the calorimeter, the thermometer must be so mounted that it is unaffected by surrounding hotter or colder objects—such as walls, windows, steam coils, &c. The readings of the psychrometer thermometers should be accurate to 1° Fahr.

III.—Heat Losses from Calorimeter.

Owing to heat interchanges between the calorimeter and its surroundings, the observed heating value will, in general, differ from the total heating value of a gas by an amount depending on the conditions prevailing during the experiment, as well as on the efficiency of the calorimeter as an absorber of the heat set free in the combustion chamber.

(*a*) *Efficiency of Calorimeter.*—An indication of the efficiencies of the calorimeters as heat absorbers was obtained by supplying heat electrically within the combustion chamber at measured rates, and observing how much of the heat was recovered in the stream of water flowing through the calorimeter. The efficiencies thus determined were found to be in excess of 99·6 per cent. for the Junkers, Hinman-Junkers, Sargent, and Simmance-Abady (English type) calorimeters, 99 per cent. for the Simmance-Abady (American type) calorimeter, and still less for the Boys calorimeter. When gas is burned in the calorimeters, the observed heating value is not the same proportion of the total heating value of the gas as is indicated by the efficiency as determined by the electric method above referred to. The net heating value (uncorrected for heat losses) found with the calorimeter would, however, be approximately the same proportion of the true net heating value as is indicated by the efficiency determined electrically.

(*b*) *Surface Losses.*—The heat loss from the surface may be considered under two heads—that due to the average excess of temperature of the surfaces of the calorimeter above the temperature of the inlet water, and a further loss (or gain) of heat due to the inlet water being above (or below) room temperature. The loss due to the former cause was determined for Junkers calorimeter (original type) No. 1209, by measuring the mean excess of temperature of its surface above that of the inlet water by means of a special surface differential thermo-couple, and by measuring the loss of heat per minute per unit area from a vessel with a nickel-plated surface similar to that of the calorimeter, from which data and the known area of the external surface of the calorimeter this heat loss was found to be 0·064 B.Th.U. per minute, when the temperature rise of the water flowing through the calorimeter was 18° Fahr., and the inlet water was at room temperature. That this heat loss is comparatively unimportant may be seen from the following considerations. In a calorimetric measurement, in which a gas of 600 B.Th.U. is burned at 7 cubic feet per hour, the rate of heat supply is about 70 B.Th.U. per minute. The heat loss of 0·064 B.Th.U. per minute therefore amounts to a little less than 0·1 per cent. This heat loss, which is sometimes called the "radiation loss," has been given an unwarranted importance in the literature of gas calorimetry—often being cited to account for large discrepancies. In non-flow calorimeters, where the total amount of heat measured is only 30 or 40 B.Th.U. in an experiment lasting ten minutes or more, this loss is of greater relative importance.

For calorimeters of a construction similar to the Junkers—*i.e.*, with the water passing through the calorimeter in but one direction, and having approximately the same area and a similar air jacket—like the Hinman-Junkers and Sargent calorimeters—the heat lost to the surroundings, under the conditions stated above, will be approximately the same as for the Junkers calorimeter. For externally water-jacketed calorimeters, such as the Simmance-Abady, this heat loss will be less.

Loss of heat due to the inlet water differing from the room temperature, and correction that must be applied when calorimeters are operated under such conditions, are considered later.

(*c*) *Position of Burner in Calorimeter and Use of Radiation Shields on Burner.*—If the burner is not set far enough up into the combustion chamber, there may be a heat loss sufficient to cause an appreciable lowering in the observed heating value—*e.g.*, in the English type of Simmance-Abady calorimeter the observed heating value was increased 1 per cent., and in the American type 1·5 per cent., by merely raising the burner 3 inches. By mounting on the stem of the bunsen burner several metal discs, perforated to admit air—thus forming what may be briefly called a "radiation shield" for diminishing the heat losses through the otherwise open bottom of the calorimeter—the heating values that are found with the several calorimeters were raised 0·2 to 0·7 per cent. The burner in the Boys calorimeter being already completely enclosed, the addition of radiation shields caused no appreciable change in the heating values observed with this instrument.

(*d*) *Conduction down Stem of Burner.*—It is shown that heat lost by conduction down the stem of the burner is negligibly small—much less than 0·1 per cent.

(*e*) *Heat Carried off by Products of Combustion.*—The products of combustion carry off from the calorimeter sensible heat proportional to their mass and excess of temperature above that of the entering air and gas, and latent heat equivalent to the latent heat of vaporization of the excess of water vapour carried out by the products over the water vapour carried in by the air and the gas. With the inlet water at room temperature, the amount of sensible heat carried off by the products was shown to be negligibly small for all the flow calorimeters tested; being not greater than 0·1 per cent. under unfavourable conditions.

The gas and air entering the calorimeter carry in an amount of water vapour determined by their volumes and their degrees of saturation; and the products carry out an amount of water vapour determined by their volume and their degree of saturation. The observed heating value will, therefore, differ from the total heating value, on account of the latent heat carried off in the products, by an amount depending on the degree of saturation of the entering air and gas and of the escaping products, and on their volumes.

The net heating values determined with the calorimeters are not affected in this way, and accurate determinations of the net heating value can therefore be made without a knowledge of the atmospheric humidity or of the volume of the entering air and of the escaping products, provided that the air supply is sufficient to ensure complete combustion.

The observed heating value may evidently be corrected for the difference in the latent heat of the water vapour carried into the calorimeter by the air and gas and that carried out by the products, if the following factors are known: (*a*) Degree of saturation of entering air, (*b*) degree of saturation of gas, (*c*) degree of saturation of products, (*d*) volume of entering air, (*e*) volume of products. Corrections taking into account all these factors, and applicable to heating value determinations of illuminating gas (600 B.Th.U.) and of natural gas (1000 B.Th.U.), under specified conditions of operation of flow calorimeters, are given later (Table XIX.).

(*a*) The humidity of the entering air may be measured with sufficient accuracy with a psychrometer of the whirling type. An Assman aspiration psychrometer was used in these experiments.

(*b*) It was shown that the wet meters used with the calorimeters delivered gas which was saturated at the temperature of the meter.

(*c*) With the Junkers, Hinman, and Sargent calorimeters, the products were found to be saturated with water vapour at a temperature practically that of the inlet water. With the Simmance-Abady (English type) calorimeter, the products were found to be saturated at the temperature at which they were discharged, which, when shields were used and the burner was set sufficiently high in the combustion chamber, was 3° to 4° Fahr. above the temperature of the inlet water.

(*d*) and (*e*) If either the volume of the entering air or of the escaping products be known, and an analysis of the gas be available, the other may be determined. For the accuracy necessary for correcting observed heating values to total heating values, the following relations between these volumes may be used—assuming that the water formed is condensed to the liquid state.

If hydrogen is burned,

volume of products = volume of air − 0·5 volume of hydrogen.

If illuminating gas (550–650 B.Th.U.) is burned,

volume of products = volume of air − 0·4 volume of gas.*

If natural gas (principally methane, CH_4) is burned,

volume of products = volume of air − volume of gas.

* Examination of a number of published analyses of illuminating gases of different character has shown that this relation may vary between the limits,

volume of products = volume of air − 0·2 volume of gas, and

volume of products = volume of air − 0·6 volume of gas.

The former relation represents the smallest contraction of volume found for carburetted water gas, and the latter relation the largest contraction of volume found for coal gas.

Full details are given of three methods of measuring the volume of air or of products (*a*) supplying air through a meter to the closed bottom of the combustion chamber, (*b*) determination of the volume of CO_2 formed by combustion of unit volume of the gas and analysis of CO_2 content of combustion products, and (*c*) measurement of velocity of combustion products through an outlet tube of known area.

These methods were applied to a number of calorimeters operated under different conditions of air supply (damper opening) and gas consumption, from which it was shown that observed heating values could be corrected to total heating values when the volume of air or of products and the atmospheric humidity were known. In a typical series of heating value determinations made with a Hinman-Junkers calorimeter, in which the calorimeter was operated with an open damper, and in which the rate of gas consumption was varied from 3 cubic feet to 12 cubic feet per hour, the volume of air drawn into the calorimeter varied from about 60 cubic feet per hour for a gas consumption of 3 cubic feet per hour, to 85 cubic feet per hour for a gas consumption of 12 cubic feet per hour—*i.e.*, increasing the gas supply four times, all other conditions remaining unchanged, increased the air supply by only about 40 per cent.; and most of this relatively small increase in air supply occurred at low rates (between 3 and 7 cubic feet per hour).

It appears from the above statement that, at the low rate of gas consumption, a large excess of air was drawn into the calorimeter (ratio of volumes air to gas = 20); while at the highest rate only a small excess of air was drawn in (ratio of volumes air to gas = 7). The various observed heating values found for the given sample of gas, when the calorimeter was operated under the different conditions stated above, all led to the same total heating value. The net heating values found were also in agreement to within the limits of experimental error.

Curves showing a relation between observed heating values and rates of gas consumption have been called capacity-efficiency curves. It is well to emphasize the fact that the form of these curves depends on the conditions of operation of the calorimeter —*e.g.*, whether the damper is opened or closed, and, if closed, the number of openings and their total area—and on the humidity and temperature of the air at the time the experiments are made. If the experiments were made on a day of high humidity, the curve would be a nearly horizontal straight line—*i.e.*, observed heating values would be nearly the same at all rates of gas consumption up to the point of incomplete combustion. The lower heating values observed at low rates of gas consumption are due to the correspondingly high values of the ratios of volumes of air to gas (and products to gas), with the resulting increased loss of latent heat of the water vapour carried out by the products of combustion, and to the relatively greater importance of surface heat losses at the low rates.

For the operation of flow calorimeters, a suitable rate for the combustion of the gas (which rate will be called the normal rate), as well as the approximate values of the ratios of air to gas and products to gas, may be found by the application of the following rule: Determine the rate of gas consumption at which combustion is no longer complete, and operate the calorimeter at 70 per cent. of that rate. This will be the normal rate for the calorimeter and gas in question for the conditions (damper opening, &c.) under which the calorimeter was operated. It was found from CO_2 analyses of products and from measurements of the velocity of the products that, at the normal rate, the volume of air drawn into the calorimeter is about 40 per cent. in excess of that actually required for the combustion, as calculated from the chemical composition of the gas. For example, with an illuminating gas of about 650 B.Th.U. the ratio of volumes of air to gas at normal rate of gas consumption is about 7 to 1. For natural gas of about 1000 B.Th.U., this ratio is about 12 to 1.

To determine the normal rate for the gas and calorimeter in question, in accordance with the above rule, it is first necessary to determine the rate of gas consumption at which combustion begins to be incomplete, a convenient procedure for which is the following: With the calorimeter in operation and with the damper set as it is to be subsequently used in testing, the rate of gas consumption is increased, step by step—*e.g.*, by successively increasing the load on the pressure regulator by adding weights. So long as the combustion is complete, the effect of increasing the gas rate is to cause an increment in the reading of the outlet-water thermometer. However, when the rate of gas consumption attains a value such that the combustion is no longer complete, there will be a decrement in the reading of the outlet-water thermometer accompanying an increase in the gas rate. The gas rate at which combustion begins to be incomplete can thus be determined to within a few per cent. An almost equally good test is that furnished by the odour of the combustion products, as the odour due to incomplete combustion is readily perceived for most gases.

The "maximum efficiency rates," as determined by the Committee on Calorimetry of the American Gas Institute, for a number of calorimeters used with illuminating gas (about 600 B.Th.U.), are practically identical with the normal rates for the same calorimeters operated under similar conditions and with the same kind of gas. It is important, however, to call attention to the fact that the maximum efficiency rate and the normal rate are not constants of the calorimeter, but vary with the conditions of operation (principally damper opening) and with the character of the gas burned—natural, illuminating, producer, &c. However, the rule for determining the normal rate takes all these factors into account, and gives sufficient information as to the values of the ratios of air to gas and products to gas; so that the necessary corrections to obtain total heating values can be determined and applied. The normal rate can also be more simply and precisely determined than can the maximum efficiency rate.

(*f*) *Effect of Atmospheric Humidity.*—From what has been said, it is evident that the observed heating values of a given sample of gas, determined with flow calorimeters, will vary with the atmospheric humidity at the time of the test. Experiments are cited of determinations of total and net heating values as made with a Junkers calorimeter, in which the air supplied to the calorimeter was measured with a meter, and in which the humidity of the air was varied from 100 per cent. to about 15 per cent. Although the observed heating values were nearly 2 per cent. lower in the latter case, they led to practically the same total heating value when the necessary corrections were applied for the latent heat of the excess of the water vapour carried out by the products over the latent heat of the water vapour carried in by the air and gas. The net heating values were independent of the atmospheric humidity, as was to be expected.

The corrections for effect of atmospheric humidity which must be applied in calculating total heating values from observed heating values determined with flow calorimeters operated at normal rates of gas consumption, and with inlet water, air, gas, and products all at approximately the same temperature, are given in Table XIX. for illuminating gas (about 600 B.Th.U.). The complete paper contains a similar table for natural gas (about 1000 B.Th.U.).

The tabular values are so calculated as to be directly applicable to observed heating values—where the term has the meaning assigned in this paper—provided the measurements are actually made at a barometric pressure of 30 inches. If the measurements are made at a place where the barometric height H differs considerably from 30 inches, the tabular corrections must be multiplied by the factor 30/H before being applied to the observed heating values. The tabular corrections are, however, directly applicable to the heating values calculated to a temperature of 60° Fahr. and the prevailing local barometric pressure.

TABLE XIX.—*Corrections in British Thermal Units, to be Applied to Observed Heating Values in Calculating the Total Heating Values of Illuminating Gases (about 600 B.Th.U.).*

[The tabular corrections are applicable when inlet water, air, gas, and products are all at approximately the same temperature, and when the calorimeter is operated at the normal rate of gas consumption.]

Temp. of Room, &c.	Relative Humidity of Air.									
	10 per Cent.	20 per Cent.	30 per Cent.	40 per Cent.	50 per Cent.	60 per Cent.	70 per Cent.	80 per Cent.	90 per Cent.	100 per Cent.
Fahr.										
40°	+ 2	+ 2	+ 1	+ 1	+ 1	+ 1	0	0	0	− 1
45°	+ 2	+ 2	+ 2	+ 1	+ 1	+ 1	0	0	0	− 1
50°	+ 3	+ 3	+22	+ 2	+ 1	+ 1	0	0	0	− 1
55°	+ 3	+ 3	+ 3	+ 2	+ 1	+ 1	+ 1	0	0	− 1
60°	+ 4	+ 4	+ 3	+ 2	+22	+ 1	+ 1	0	0	− 1
65°	+ 5	+ 4	+ 4	+ 3	+ 2	+ 2	+ 1	0	− 1	− 1
70°	+ 6	+ 5	+ 4	+ 3	+ 3	+ 2	+ 1	0	− 1	− 2
75°	+ 7	+ 6	+ 5	+ 4	+ 3	+ 2	+ 1	0	− 1	− 2
80°	+ 8	+ 7	+ 6	+ 5	+ 4	+ 3	+ 1	0	− 1	− 2
85°	+10	+ 9	+ 7	+ 6	+ 4	+ 3	+ 2	0	− 1	− 3
90°	+12	+10	+ 9	+ 7	+ 5	+ 4	+ 2	0	− 2	− 3
95°	+14	+12	+10	+ 8	+ 6	+ 4	+ 2	0	− 2	− 4

IV.—TEMPERATURE OF INLET WATER.

The frequently-made recommendation that the calorimeter be operated with the inlet water at a temperature sufficiently below the room temperature so that the observed heating value shall be equal to the total heating value, is considered; and it is shown that the amount by which the inlet water temperature would have to differ from the room temperature in order to accomplish this result would be different under different conditions. Indeed, from Table XIX. it is evident that, neglecting the surface heat losses, under some conditions it would be necessary to operate the calorimeter with the inlet water above the room temperature.

It is recommended that flow calorimeters be operated with the inlet water at, or nearly at, the room temperatures; so that no correction need be applied for the difference between the inlet water and the room temperatures. Where such correction is necessary, Table XXI. may be used. In this table are given, for various room temperatures, the amounts per 1° Fahr. difference between the room temperature and the inlet water temperature, by which the total and net heating values, calculated as if the inlet water had been at the room temperature, must be corrected on account of such difference in temperature. The corrections calculated from this table may be applied, without sensible error, to the heating values of illuminating gas (about 600 B.Th.U.) determined with any of the flow calorimeters listed in this paper (except the Doherty calorimeter); the correction being added if the inlet water is warmer than the room, and subtracted if the inlet water is colder.

TABLE XXI.—*Corrections per 1° Fahr. Difference between Inlet Water Temperature and Room Temperature for Conditions stated above.*

Room Temperature. Degrees Fahr.	Corrections in B.Th.U. for Calculating Total Heating Value.	Corrections in B.Th.U. for Calculating Net Heating Value.
50	0·5	0·4
60	0·6	0·4
70	0·7	0·4
80	0·8	0·4
90	0·9	0·5
100	1·0	0 5

The corrections would be the same for all the calorimeters if it were not for the differences in the surface losses. The tabular values are average values for all calorimeters, and therefore slightly too large for the Junkers, the Sargent, and the Hinman-Junkers calorimeters, and somewhat too small for the Simmance-Abady and Boys calorimeters. However, for differences of a few degrees, the error due to the use of the tabular corrections will be unimportant for any of the calorimeters mentioned.

V.—Constancy of Flow of Water and of Gas. Efficiency of Gas-Pressure Regulators.

The effect of entrapped air in causing fluctuations in the water flow, and hence in the readings of the outlet-water thermometer, has already been referred to. A number of experiments were made to test particular features of operation of pressure regulators of the float type; the general conclusion being that such regulators will maintain the pressure sufficiently constant for no significant error to be introduced into the measurements due to the effect of fluctuations of the gas rate. The regulation is not sufficiently good, however, to warrant the calculation of heating values from observations of the rate of water flow and of gas flow, instead of the usual procedure of determining the amount of water collected during the combustion of a measured volume of gas.

VI.—Time Required for the Attainment of Thermal Equilibrium in Flow Calorimeters.

An essential condition for the correct measurement of heating values with flow calorimeters is that thermal equilibrium shall have been established before the calorimetric observations are begun. It was shown that the time required for the establishment of thermal equilibrium depends largely on the design of the calorimeter—being about five minutes for calorimeters of the Junkers type, and about thirty minutes for those of the Boys type. The times required for different calorimeters to attain a condition of thermal equilibrium are by no means proportional to their respective water contents. However, a calorimeter of large water content will be slow in showing at the outlet the effect of changes in the temperature of the inlet water, and requires, for satisfactory operation, a water supply at very constant temperature. If sufficient time is allowed for the attainment of thermal equilibrium, and if the conditions—character of gas, rate of flow of water and of gas, &c.—can be maintained sufficiently constant, no error due to the time lag of the calorimeter need be introduced into the measurements, even with calorimeters of large time-lag.

VII.—Measurement of Water Condensed in Calorimeter. Net Heating Value.

It was shown that for most of the calorimeters the drainage of the water condensed from the products of combustion was sufficiently regular for the net heating values to be calculated with enough accuracy from the amount of water collected during the combustion of about one cubic foot of gas, provided the calorimeter had been in operation a sufficient length of time before the collection of the condensate was begun. The conditions are discussed which tend to promote uniformity of drainage of the condensate, and attention is called to the irregularity of drainage from a water surface of large area. For the calculation of the net heating values, the heat of vaporization of water should be taken as 2·3 B.Th.U. per cc. of water.

VIII.—Manipulation of Change-Over Device.

While considerable accidental errors, affecting individual determinations, are possible in this manipulation, it is not likely that the mean of a number of tests would be affected by a constant error due to this cause. Experiments made to test the magnitude of errors in the manipulation of the change-over device showed that the resulting error in a heating value determination attained 0·4 per cent. in a single determination, though on the average such errors, for a single determination, were less than 0·2 per cent.

IX.—Weighing or Measuring the Water.

It is easily possible to weigh the water with an accuracy beyond that required in calorimetric experiments. If the water is weighed, both the correction for reduction to weight in vacuo and that for the variation in the specific heat of water may be omitted, as both the corrections are small, and are usually opposite in sign. If the water is measured in an ordinary cylindrical graduate, great care in reading is necessary if an accuracy of 0·2 per cent. in this measurement is required. By using a graduate in which the lower portion is enlarged, the required accuracy may readily be attained. To allow for the combined effects of the variation with temperature of the specific heat of water and the thermal expansion of the water and of the graduate, the observed volumes should be multiplied by the factors K for temperatures T, as given in Table XXII., where T is the temperature of the outlet water, in order to obtain the equivalent mass of water at 15° C. (or at 60° Fahr.). An additional correction must be applied if the volume of the graduate at 15° C. (or at 60° Fahr.) is in error.

TABLE XXII.—*Factors for Reduction of Volumes of Water, Measured at T°, to Equivalent Mass of Water at 15° C. (or at 60° Fahr.). Multiply Observed Volume by Factor K.*

T.	K.	T.	K.
Degrees Fahr.		Degrees C.	
60	1·001	15	1·001
70	0·998	20	0·998
80	0·995	25	0·996
90	0·993	30	0 994
100	0·991	35	0 992
110	0·989	40	0·991
		45	0·989

The amount of water lost by evaporation between the time the water leaves the calorimeter and the time of weighing or measuring is negligible.

X.—Measurement of Volume of Gas.

This has been considered in the section relating to gas-meters.

XI.—Leakage of Gas.

Tests for leakage of gas between the meter and the burner are outlined, and attention is directed to the necessity for reducing the leakage to a negligible amount.

XII.—Measurement of Atmospheric Pressure.

The errors to which measurements of atmospheric pressure by means of mercury barometers are liable are briefly considered. In order that the error in the measurement of the gas volumes, and hence in the resulting heating value, may not exceed 0·1 per cent., the barometric pressure must be measured with an accuracy of 0·02 or 0·03 inch—an accuracy which is readily attainable. Since the total correction to the barometer is usually negative, it is possible, by suitable adjustment of the gas pressure at the meter inlet, to make the total pressure of the gas equal to the observed barometric reading; thus avoiding the application of all barometer corrections.

XIII.—Effect of Fresh Water in the Gas-Meter.

The observed heating value determined immediately after filling the meter with fresh water was only about 0·5 per cent. lower for the sample of illuminating gas tested than the values observed after several cubic feet of gas had been passed through the meter. This source of error can be reduced to negligible proportions (for calorimetric measurements) by passing several cubic feet of gas through the meter before beginning measurements.

XIV.—Effect of New Rubber Tubing.

An experiment was tried to determine the effect of absorption of gas by new rubber tubing. A 33-feet length of rubber tubing was found to cause a lowering in heating values of 2 per cent. at the start; and at the end of 29 hours the heating values were still 0·5 per cent. low. To reduce the error due to this cause, only short lengths of rubber tubing should be used in making connections; and the tubing should be thoroughly saturated with the gas before being put into use.

XV.—Effect of Cooling Gas on Heating Value and on Candle-Power.

As is well known cooling a gas produces a smaller effect on the heating value than on the candle power. For the oil enriched gas used in these tests, passing the gas through an iced coil produced a lowering of 0·7 per cent. in the heating value and of 12 per cent. in candle power in one experiment.

XVI.—Deterioration in Heating Value of Gas in Holder.

The gas used in these experiments was found to decrease in heating value about 1 per cent. per day, when allowed to remain in contact with water in a 5 cubic feet meter-prover. The experiment is of importance in directing attention to the necessity for making the tests on the same day that the sample is taken, unless the effect of storage is investigated.

Résumé of Factors Affecting Heating Value Determinations.

The foregoing discussion of the errors that may affect the various measurements and manipulations incident to the determination of heating values with flow calorimeters may, at first sight, seem rather formidable and leave the impression that the final accuracy of such determinations may not be as high as is desirable or even as is required in industrial testing. However, experience has shown that, if due attention is given to the precautions that have been shown to be of importance, an accuracy better than 0·5 per cent. is attainable, and in ordinary routine testing an experienced observer should obtain results accurate to within about 1 per cent. The accuracy attainable is mainly limited by errors in adjusting the gas-meter, in measuring the temperature rise of the water, and in manipulating the change-over device,

since the errors due to other factors may, by proper procedure, be made nearly, if not quite, negligible. It is necessary, therefore, that the observer shall give special attention to the three factors mentioned.

The results are given of a comparison of heating values obtained with flow calorimeters with heating values obtained with calorimeters of the Berthelot bomb type. Samples of gas were stored in a 5 cubic feet gasholder, and the total heating values were determined with flow calorimeters. In this determination all the precautions which had in the preceding sections been shown to be necessary were taken, and all the necessary corrections were applied. The heating values of the samples of gas were also determined with calorimeters of the Berthelot bomb type. Two different bombs were used. The bombs were filled at atmospheric pressure with the gas to be tested, sufficient oxygen under pressure was added, and the heat evolved when the charge was fired was determined in a calorimeter in the usual way, the rise of temperature of the calorimeter being measured with a platinum resistance thermometer. The results obtained, being heats of combustion at constant volume, were corrected to give the heat of combustion at constant pressure.

With natural gas and with nearly pure hydrogen, the results obtained with the flow calorimeters agreed with those obtained with the bomb calorimeters to within the limits of experimental error—*i.e.*, to about 0·3 per cent. In testing illuminating gas the results obtained with the bomb calorimeters were about 1 per cent. lower than those obtained with the flow calorimeters. This discrepancy requires further investigation.

Descriptions of Calorimeters.

Section IX. contains descriptions and illustrations of all the calorimeters included in the investigation, as well as the results of tests of various features of the several calorimeters.

(1) *Junkers Calorimeter* (*Original Type*).—With burner mounted in the highest position in which it can be set in the instrument as furnished, there is a reheating, amounting to several degrees Fahrenheit, of the products of combustion in the base of the calorimeter. By modifying the burner support, so that the burner could be raised about 1½ inches, and by using radiation shields on the burner, the reheating of the products was avoided, so that they were discharged at practically the inlet-water temperature (within 1° Fahr.). While the reheating of the products does not involve any significant loss of heat, it has often created an erroneous impression as to the efficiency of the heat-absorbing system of the calorimeter. The efficiency of this and the other calorimeters as heat absorbers, as determined by experiments with the electric heating coil, as well as the surface losses from the calorimeters, have already been referred to. This calorimeter was used in most of the comparisons referred to in the preceding section, where it was shown that total heating values, determined with this calorimeter, were in agreement with those found with the bomb calorimeters, within the limits of experimental error of the intercomparisons (0·3 per cent).

(2) *Hinman-Junkers Calorimeter.*—This calorimeter differs from the Junkers (original type) calorimeter only in some details of construction. Comparison of a Hinman-Junkers calorimeter with a Junkers calorimeter indicated that the results obtained with the two calorimeters were in agreement (within the limits of experimental error) of the intercomparisons (0·2 per cent.).

(3) *Sargent Calorimeter.*—This calorimeter differs from the Junkers (original type) calorimeter only in details of construction. Comparison of a Sargent calorimeter with a Junkers calorimeter indicated that the results obtained with the two calorimeters were in agreement within the limits of experimental error of the comparisons (0·2 per cent.).

(4) *Junkers Calorimeter* (*New Type*).—This calorimeter differs radically in design from the original type of Junkers calorimeter. In the calorimeter tested it was found that the outlet water was not sufficiently mixed to ensure uniformity in temperature throughout the effluent stream of water, so that the indications of the outlet-water thermometer depended on the position of the bulb in the effluent stream. The defect was easily remedied by the addition of a suitable mixing device. The attention of the makers has been called to this defect. With the mixing device in position, it was found that the heating values obtained with the calorimeter were in agreement with those obtained with the original type of Junkers calorimeter to within the limits of experimental error (0·2 or 0·3 per cent.).

(5) *Simmance-Abady Calorimeter* (*English Type*).—This calorimeter, not being provided with an inlet overflow weir, requires the use of some device to maintain constant the flow of water through the calorimeter, if the pressure of the supply is variable. The change-over device for the outlet water is adapted to the so-called "snap-test"—a method of testing which is shown to be unreliable. In the calorimeters tested, the burner support was too low. Raising the burner 3 inches, and providing radiation shields, increased the observed heating value from 1 to 1·5 per cent. The products of combustion were discharged from the calorimeter at a temperature 3° to 4° Fahr. above that of the inlet water. As the products were saturated at the temperature at which they were discharged, it is evident that they had not been cooled down to the inlet-water temperature—*i.e.*, that the calorimeter is not quite as efficient, as a heat absorber, as are the calorimeters previously described. However, the loss of heat, due to the fact that the products are not cooled to the inlet-water temperature, would rarely amount to more than 0·2 per cent. of the heating value of an illuminating gas. It was found that there were differences of temperature in the effluent stream of water, so that the outlet-water thermometer did not indicate the true mean temperature of the stream. The addition of a mixing device in the outlet-water tube obviated the defect. The water content of this calorimeter is unduly large (14 lbs. of water), so that the requirement as to constancy of temperature of the inlet water is greater than for the other calorimeters. When a change-over device was substituted that enabled the usual method of testing to be used instead of the "snap-test," when the burner was raised and the radiation shields were provided, and when a mixing device was used in the outlet-water tube, it was found that the heating values obtained with this calorimeter were in agreement—within the limits of experimental error (0·2 or 0·3 per cent.)—with those obtained with the Junkers calorimeter.

(6) *Boys Calorimeter.*—The Boys calorimeter utilizes the radiator coil type of heat interchanger. When the luminous-flame burner was used, the beginning of incomplete combustion (at about 4·7 cubic feet per hour for the gas tested) was very sharply defined by the appearance of smoke in the escaping products, even before the observed heating value was measurably diminished. The hole through the cover for the outlet products thermometer was so located that there could be but little circulation of the products past the bulb. A thermometer mounted in this opening indicated a 5° or 6° Fahr. excess of products temperature above the inlet-water temperature, while a thermometer mounted with its bulb in one of the larger holes, so that the products flowed past the bulb, indicated an excess of only 3° Fahr. A long time is required for this calorimeter to attain a condition of thermal equilibrium—much longer than for the calorimeters already described. The calorimeter should be placed over the lighted burner, and steady conditions should prevail for about 30 minutes before observations are begun. The drainage of condensate was found to be somewhat irregular, as might be expected when the drainage takes place from a water surface of large area. Net heating values determined with this calorimeter are, therefore, apt to be inconsistent. Several careful comparisons with the Junkers calorimeter showed that the heat losses from the Boys calorimeter were very appreciable, since the observed heating values found with the Boys calorimeter were about 2 per cent. lower than those found with the Junkers calorimeter.

(7) *Simmance-Abady Calorimeter* (*American Type*).—In this calorimeter, as in the Boys, the radiator coil type of heat interchanger is used. Raising the burner three inches and the addition of radiation shields increased the observed heating values about 1·5 per cent. This calorimeter has a very great lag, requiring an even longer time than the Boys calorimeter to attain thermal equilibrium. That this lag was due to a great extent to the heavy metal chimney forming the combustion chamber was shown by the fact that the lag was reduced to about one-third of its original amount by replacing the heavy metal chimney by one of very thin sheet metal. The experiments made with the electric heating coil to determine the efficiency of the calorimeter as a heat absorber indicated that this efficiency was about 99 per cent. Comparisons with the Junkers calorimeter indicated that observed heating values found with the Simmance-Abady calorimeter with heavy metal chimney were about 1 per cent. lower, while the values found when the light chimney was used were less than 0·5 per cent. low.

(8) *Doherty Calorimeter.*—This calorimeter differs from the other flow calorimeters in that the water flowing through the calorimeter is caused to displace, from a tank, the gas under test. Since equality in the volumes of water heated and of gas burned is thus secured, the use of a gas-meter and the measurement of the water are dispensed with. The calorimeter itself was found to give results about 1·3 per cent. lower than the Junkers calorimeter, when used as an ordinary flow calorimeter. This lower calorimetric efficiency is in large part compensated, in the regular method of operating the calorimeter, by the gain of heat from the surrounding gas tank. Since the gas under test is displaced from the tank by the heated water from the calorimeter, it follows that the most favourable conditions for accuracy in the measurement of the gas are secured when the outlet water is at room temperature. It was found that when the calorimeter was operated with the inlet water at such a temperature that the outlet water was at room temperature, the observed heating values obtained with the Doherty calorimeter were in agreement with those obtained with the Junkers calorimeter—within the limits of experimental error (about 0·5 per cent.). If the corrections for effect of atmospheric humidity (Table XIX. or XX.) are applied, the total heating values can be obtained with this calorimeter, when operated as above described. When the calorimeter was operated with the inlet water at room temperature, the observed heating values were found to be about 1 per cent. lower than those found with the Junkers calorimeter. The calorimeter is not well adapted to the determination of net heating values.

(9) *The Parr Gas Calorimeter.*—In this instrument two similar calorimetric systems are provided, in one of which a known volume of hydrogen is burned, while in the other a known volume of the gas under test is burned. The ratio of the heating value of the gas under test to that of hydrogen is thus directly determined from the observed rise in temperature of the two calorimeters. Tests were made to determine the equality of the two calorimetric systems, and to find how nearly the assumption that the ratio of heating values is equal to the ratio of temperature rises of the two calorimeters holds true when the temperature

rises differ very much from equality. These tests led to the conclusion that it is preferable to make the temperature rises in the two calorimeters approximately equal. In the testing of illuminating gas, this is done by burning two volumes of hydrogen under one calorimeter, and one volume of illuminating gas under the other.

Since the heat interchange with the surroundings is of considerable importance, on account of the small amounts of heat imparted to the calorimeters, the times of reading the initial and the final temperature of each calorimeter should be so chosen that the heat interchange with the surroundings, in the interval between these times, is proportional to the temperature rise in each calorimeter. If the initial temperatures are so chosen that the final temperature of each calorimeter will be equal to the room temperature, the time elapsing between the initial reading and the ignition of the gas should be the same for each calorimeter. As, in these circumstances, the final temperatures are practically stationary, the exact timing of the final readings is of little importance.

The rate of heat communication to the calorimeter by the small pilot lights that are momentarily swung into position under each calorimeter, in order to ignite the gas, cannot be made much less than 25 per cent. of the rate at which heat is communicated by the calorimeter burners; so that an appreciable error may be introduced into the result of a heating value test unless the observer so manipulates these pilot lights that the difference in the amount of heat thus communicated to the calorimeters is negligible. Owing to the small rise of temperature that is measured in the Parr calorimeter, the precision attained in a single determination is not high (from 1 to 2 per cent.); but, as systematic errors are not likely to occur, provided the calorimeters are thermally equivalent and the volumes of the gas cylinders are correctly adjusted, the mean of a number of experiments, in which the thermometers are interchanged, is considerably more accurate. This calorimeter is not adapted to the determination of net heating values.

Since the ratio of heating values found with the Parr calorimeter must be multiplied by the number representing the heating value of hydrogen in order to find the heating value of the gas under test, the results obtained with the calorimeter will depend on what value is taken as representing the heating value of the hydrogen. The results obtained for the heat of combustion of hydrogen by five different experimenters have been summarized by Roth in the "Landolt-Börnstein-Behn Physikalische Chemische Tabellen," Table No. 198a, p. 908. The mean of the five results is 68,700 calories per molecule of hydrogen, which corresponds to a total heating value, as defined in this paper, of 321 B.Th.U. per cubic foot—a value which was used in computing the results obtained with the Parr calorimeter.

The Parr gas calorimeter No. 2 was compared with the Junkers calorimeter, and it was seen that the total heating values found with the Parr calorimeter were in agreement with the total heating values found with the Junkers calorimeter, to within the limits of experimental error (about 0·5 per cent.).

THE PRINCIPLES AND FUNCTIONS OF A STATION METER.

By F. R. Parsons.

It may be considered by some hardly necessary to explain in detail the principles and functions of a station meter, seeing that this is a piece of apparatus the fundamental principles of which were in use by Clegg, who is accredited with the introduction of the wet meter, nearly a hundred years ago. Nevertheless, it has been the present writer's experience to find that there are to-day many men responsible for the management and up-keep of a gas-works who are almost unfamiliar with the principles governing the working of this particular piece of mechanism. To a certain extent this is not altogether to be wondered at, seeing that it may so happen that a gas manager might spend the best years of his life in one or more gas-works and yet never once have an opportunity of examining internally that which his eyes rest upon externally perhaps every working day of his life.

The reason for this, again, is not hard to seek. A station meter is a piece of mechanism which, when once fixed and in good order, is capable of performing its particular functions year in and year out without any attention whatever beyond that of a periodical renewal of a naturally lowering water-line. Moreover, the comparatively low speed at which, under normal conditions, it works, the relatively small number of moving parts attached to it, its complete immunity from any of the injurious factors common to moving mechanism which is periodically or continuously subjected to strains and stresses, make it a piece of machinery which only chemical deterioration and natural decomposition of metals can seriously affect. True, causes do sometimes arise, other than those just mentioned, which tend to break this continuity of service; but in nine cases out of ten these can almost invariably be traced to a mechanical defect—unpreventable, perhaps, in some cases, due to negligence in others, which necessitates the dismantling of a meter in order to renew or repair the faulty detail in question. Beyond this, cases have been known to the writer where a station meter has recorded an unbroken service of from thirty to forty years without its interior once being permitted to see the light of day.

The purpose of this article is an endeavour to make clear to those who may not be altogether familiar with the working of a station meter the principles and functions which govern this piece of apparatus, to show how its movement is effected, to explain the principles of measurement and method of registration, to illustrate how its capacity per revolution and cubical contents are determined, and to touch upon the question of accurately determining the correct water level in order to provide for, and maintain, an unvarying accuracy of results. In passing, references will also be made to points in connection with the manufacture of station meters, in order to enlighten those who may be interested in this particular phase of the matter.

Details of Construction.

The better to grasp what follows, let us first of all examine the sectional elevation of a cylindrical station meter, as shown in fig. 1. As will be seen, it comprises an outer cast-iron cylindrical case A, to the ends of which are attached the flat cover plates B. To the inside of the back plate there is fixed centrally the gas inlet spout C, which also serves as a support for the bearing D, to carry the drum shaft. Centrally on the inside of the front cover is provided a projecting boss E, into which the swivelled bush is inserted for carrying the front end of the drum shaft. The latter extends through the front plate, as shown, in order to attach a gear wheel for driving the index mechanism; this being simply to record the revolutions of the drum. The latter is mounted on the shaft through two cast-iron plates F, provided with bosses and strengthening webs, bolted at either end to the quarters or partitions, and, in the case of drums of extra large size, are stayed at intervals through the centre.

The back or gas inlet end of the drum is provided with a domed end, in which is contained the inlet spout C. The top of the latter reaches upwards inside the crown, and above the intended water level; the inlet gas passing through this and into the upper chamber of the drum through the partition openings provided at the end of the latter. The drum G is cylindrical in shape, and internally is divided into four quarters or partitions. These are attached to the inner periphery of the drum, and fixed obliquely to its axis—being curved on their outer edges to form a circular area through the drum centre. In appearance they also partake

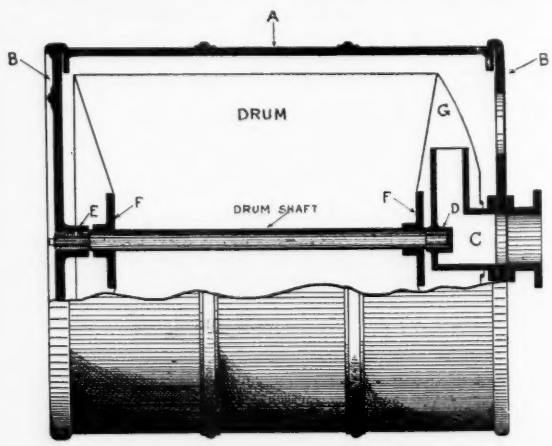


Fig. 1.—Sectional Elevation of a Station-Meter.

of the nature of a screw, so that their passage through the water shall offer as little resistance as possible. The ends of these several partitions are returned, both at the back and front, and overlap each other, thus permitting a space between each one for the passage of gas and water during its revolution. These openings may be seen in the other end view of the drum in fig. 2. In the same figure will also be seen the method of supporting the shaft. Removable covers, as appearing in the illustration, are also provided in drums of larger size so as to enable convenient access for inspection, &c.

Drum-Actuating Mechanism.

Coming, now, to the method by which the gas actuates the drum, it must first be understood that the meter contains water to a level which shall effectually seal the central hole through the drum—in other words, shall cover the inner edges of the four partitions. If this were not insured, it is obvious that gas entering the meter from the inlet spout could pass unhindered right through the drum, through the end partition spaces at the front of the meter, and so outside the drum and back to the outlet connection into the mains. Consequently, while this was happening the drum would be stationary and gas passing unrecorded.

But let us see what occurs when this open space through the axis of the drum is sealed. When gas is admitted through the

spout, it will at once enter one of the upper partitions above the water level, and, by reason of its pressure on the surface of the water and against the inclined surface of the partition of the drum, will cause the latter to revolve—thus exposing more of the quarter until its whole area has been above the water level. Just previously to this occurring, however, the next partition is appearing above the water level, and is, in turn, being acted upon by the inflowing gas; while that in the first partition is being expelled through the spaces in the quarters at the outlet or front end of the drum, into the outer case, and so back to the outlet connection, by reason of the partition entering the water and displacing the gas.

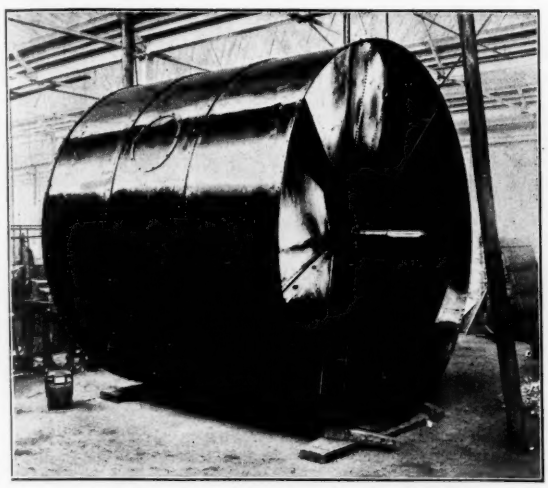


Fig. 2.—View of Drum, Showing the Gas-Outlet End.

It must be obvious that actual measurement of the gas takes place within the area of each partition governed by the internal diameter of the drum on the one hand, and the water line, or surface, on the other—that is to say, the portion of the quarter that is exposed to the gas and is above the water level. This being so, it will be equally obvious that this area once having been ascertained—and the method of doing this will be dealt with later on—it is essential that some provision be made whereby a strict maintainance of the area be observed. Seeing that the limitations of the drum diameter is an unalterable factor, and cannot be reckoned with, the only other means of obtaining this latitude is by adjusting the surface level of the water. Thus if, allowing just sufficient margin to seal the central space through the drum, the level of the water is kept at its lowest limit, we have a drum giving its maximum capacity at each revolution; and as this water line is raised, so the capacity decreases *pro rata*—that is to say, that by the addition of a cubic inch of water, a cubic inch of gas space is lost.

The Auxiliary Appliances.

The determining and maintaining of this water-line is the most important feature in connection with a station meter. The fixture intended to insure this usually takes the form of what is known as the automatic water-line and overflow, consisting of a sealed, glass-fronted box attached direct to either the front or back plate of a meter, and having communication with the water inside the meter. An open-ended tube is fixed centrally and vertically in this box, having its upper open end adjusted to the predetermined level of the water. Therefore any water admitted to the meter over and above that required to maintain the correct level flows over the top of the tube, and so away. Gas at inlet pressure is carried to the box to depress the water therein; so that it will coincide with the level of that within the meter—the gas being prevented from passing down the overflow tube by means of a syphon connected to the lower extremity of the tube.

The index or recording mechanism denotes the revolutions made by the drum only, without taking into account the observance of the due proportions of water and gas. In this case, the drum motion is imparted through another shaft direct-driven off a pin engaging with a slotted disc on the spindle working in a stuffing box, and attached centrally at the front. The tell-tale (so-called) is simply a revolving metal disc geared-down with the index, and so arranged to hold a paper disc to its face (the sheet being graduated into thousands of cubic feet). Pivoted to the minute hand of the clock is a light connecting rod sliding in a guide, and terminating with a spring pen or pencil, which, bearing lightly against the revolving paper disc, makes a vertical movement, once up and once down, every hour. By means of this contrivance, any irregularity in the hourly make of gas can at a glance be detected.

Other fittings usually attached to the front of a station meter are a single-tube water-line, and a differential pressure-gauge. The former is, in common form, just a glass tube with its lower end in communication with the water inside the meter. Its purpose is to show at a glance if the water is being kept at the required level. It forms, however, no part of the overflow fitting earlier described—this being usually found at the back of a meter. The pressure-gauge has no communication internally with the meter, but is fixed on the front for the sake of convenience as well as appearance. It is so arranged, by means of suitable connections and cocks from the gas inlet and outlet pipes at the back of the meter, to show either pressure at will.

Testing the Drum and Fixing the Water-Level.

We now come to the most important feature in connection with station meters—that is, the testing, calibrating, and ascertaining the correct drum area, and fixing the water level. Upon this, the writer would like to pass a few comments before detailing the *modus operandi* usually adopted. First of all, it must be clearly understood that this operation, simple as it might appear, is in reality one which only experts in meter-testing should undertake; and for this reason. A station meter might to the uninitiated give in such a test all the indications which would point to perfect construction and correct registration, and yet to the eye and ear of an expert be both mechanically and fundamentally wrong. The eye, nose, and ear must all be called into requisition when conducting such a test. An erratic, jerky movement of the drum, though invisible from the exterior, might to the practised eye be sufficiently visible in other directions to indicate the presence of some mechanical defect. A slight leak, if occurring in certain sections of the apparatus, and too often regarded as being of no importance, is sufficient to nullify and render abortive any test, no matter how religiously applied otherwise. Sounds, unintelligible and meaningless to the inexperienced, often convey to the expert ear information which is invaluable in the location of a fault.

The general behaviour of the test meter while at work, the variation in pressures and temperatures, the movements of the index mechanism, the rise and fall of the water within the overflow apparatus, the quantity of gas passing per minute, are all factors, equally potent each in its own way, to be religiously observed and duly considered as being indicative of the general conditions under which the station meter is working. For this reason, if for no other, the writer would strongly urge all users of station meters to have them tested if necessary by a properly-qualified expert. In every case it is money saved in the end; and the assurance from such an individual that a meter is correct and in perfect order, both constructionally and in registration, is worth far more than all the surmises and conjectures of inexperience, which only tend to induce perpetual worry and anxiety as to the make and output of gas.

To calculate the working area of a drum or one of its quarters by mensuration rules might be accepted as being an arrival near enough to the truth when regarded from a constructional aspect only. The difference when an actual capacity test is applied may, however, be astounding; and for this reason. The amount of obliquity or inclination with which the quarters are set in the drum may vary much or little with each one, thus accounting for a corresponding difference in area. But having to deal with the sum of these separate areas contained in one revolution, individual discrepancies in this respect are almost immaterial.

The chief requisite uecessary for testing a station meter is a standard test meter. It should be capable of passing not less than 120 cubic feet per hour at a minimum pressure of 5·10ths of an inch. It should be provided with a special index having an outer dial graduated to $\frac{1}{100}$ of a cubic foot, an adjustable pointer, and release valve. A pressure gauge, thermometer, and adjustable screws set in the feet for accurate levelling must also be included. In addition, the test meter must be made in every respect in strict accordance with the Board of Trade specifications, approved and tested as to accuracy, and must bear the seal of the Board of Trade inspector. [Parenthetically it might be stated that these particulars are given in order to show how futile a test would be considered if made with an ordinary wet meter not conforming in any respect with these requirements.]

To conduct a test this meter now needs levelling-up on a stage near the front of the station meter under test, in order that both indices may come under easy observation for reading simultaneously. An independent gas supply must be connected to the inlet of the test meter. This need not exceed ¾ inch in diameter. The outlet from the test meter should next be connected to the inlet of the station meter. In the case of a meter being tested *in situ*, with all valves and connections jointed up, this may be done by drilling and tapping a hole in the inlet connection on the meter side of the inlet valve—making sure that both inlet and outlet valves are perfectly sound. This is highly important; and in order to feel assured on this point, leave nothing to chance. A similar sized hole may require drilling and tapping in the outlet connection from station meter, so as to lead away into the atmosphere the consumed gas. If the test is being conducted in an ill-ventilated house or building, carry this outlet pipe through a convenient window or doorway.

The method usually adopted in connecting-up both meters for a capacity test is indicated in fig. 3. It is usual to first test all joints and the meter itself for absolute soundness. To do this, plug-up the outlet hole on the station meter, then turn on the gas at full pressure into the test meter, and thence into the station meter. Now watch the index pointer on the test meter. At first a slight oscillation may be observed on the finger, due to the change of temperature and the disturbance of the water as it is being pressed by the gas. This, however, will quickly subside; and if all the joints, and the meter itself, are sound, the index finger will become, and remain, quite steady.

At this stage we are ready for a test. First see that the station

meter index is pointing definitely to a known figure on the dial, so that an accurate reading might be taken. If we assume that the drum is one having a capacity of 100 cubic feet per revolution, then the record of an index dial whose pointer moves a complete revolution must be taken. The first dial of a station meter index is usually graduated into ten divisions of ten feet each, so that this will serve; but no part of a revolution on the

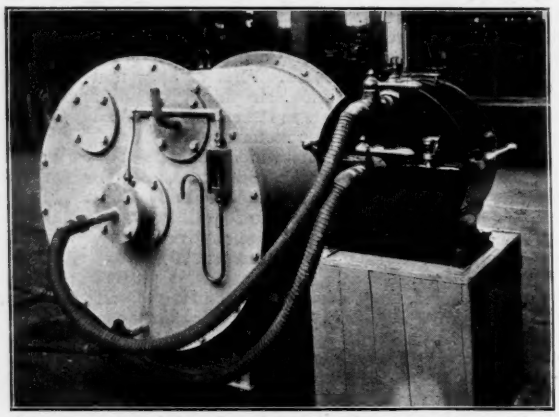


Fig. 3.—A Station-Meter Connected-up Ready for a Capacity Test.

dial must be taken, as the graduations thereon are not always found to be uniform. Now bring the test meter index to zero, and start the gas flowing through the meters. Two essential points must here be observed—do not over-run your test meter (3 feet per minute being the maximum rate at which one of the type described should be driven); also regulate the inlet cock to the test meter so that the pressure is kept as low as possible, since a station meter drum, when running in good order, should only absorb 5·10th, or ½ inch, water pressure in actuating it.

The index on the station meter should now be closely watched. When one revolution of the drum is nearing completion, someone should be in readiness to close the supply to the test meter (upon a signal given) the moment the index pointer is again on the exact spot whence it started. Having done this, compare the two readings. If, for example, the station meter shows a consumption of just 100 cubic feet and the test meter reading is (say) 98·5, then the station meter is 1·5 cubic feet fast. This, in turn, shows that the gas area of the drum above the water level is too small. Consequently the latter will require lowering.

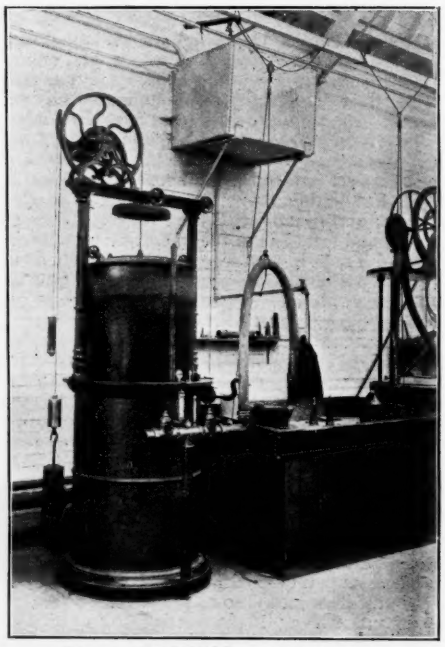


Fig. 4.—A Test-Holder and Equipment.

Before this is done, however, any difference existing between the temperature of the outlet gas from the test meter and that of the station meter should be carefully noted, as 2° of temperature makes a difference (roughly) of ½ cubic foot in the calculation; or, in other words, ½ per cent. For instance, if in the foregoing example the outlet temperature from the station meter was 50° Fahr., and that of the test meter 48°, then the correct reading of the station meter would be 100·5 cubic feet. In this case, the meter would be 2 per cent. fast.

It has been stated that the water line needs lowering. To do this, the automatic overflow tube will require shortening. In testing a meter the first time to ascertain this level, it is always an advantage to leave this tube sufficiently long, so that when the correct level of the water is found, it can be cut down until the water just trickles over it and through the leg of the syphon. Of course, if the error in registration is the other way about, and the area in the drum above the water level too great, then the meter is slow. In this case, the area needs restricting; the overflow tube raised; and more water added. The Board of Trade regulations concerning the registration of wet meters permit a margin of 3 per cent. slow, and 2 per cent. fast. Therefore any result that comes within these limits is, to all intents and purposes, assumed to be correct, and will pass an official test.

Perhaps to some the illustration given in fig. 4 may not be without a little interest. It represents a typical testing holder of a pattern approved by the Board of Trade and used for testing small gas-meters, either of the wet or dry type. It consists of a tank and inverted bell, the latter running freely on rollers up guides or columns, its open end immersed in water, and usually of a capacity of not less than 10 cubic feet. Pressure on the outlet is applied by means of suitable weights acting directly on the bell, or reduced by adding weight to the extremity of the rope which actuates it. A graduated scale dividing each cubic foot into fiftieths is fixed at the front, and the readings are observed through a powerful lens provided with a double hair line to insure perfect accuracy. These test holders can be used with either gas or air.

FORMATION OF BLACK SALTS OF AMMONIA.

The subject of the formation of certain black salts in the manufacture of sulphate of ammonia has been dealt with by Heer J. Van den Bossche in an article which appeared in "Le Chimiste" for February. The following is a translation of the principal portions of the article, which furnishes particulars supplementary to those contained in the "JOURNAL" for the 24th ult. (p. 831).

The author attributes the formation of the black salts in question to the small quantities of iron which always exist in the form of sulphate in the sulphuric acid employed. Sulphate of iron is a salt much less soluble than is sulphate of ammonia. Consequently, if the crystals of the latter are introduced into a concentrated solution of sulphate of iron, they will pass into solution, and precipitate the sulphate of iron in crystals. Likewise, if a concentrated solution of sulphate of ammonia in sulphuric acid containing iron is neutralized with gaseous ammonia, the iron will crystallize and deposit at first. This is the case with saturating solutions employed to absorb the ammonia in gas or vapours from distillation processes; and the sulphate there obtained always contains an appreciable amount of ferrous salts. Any sample of commercial sulphate of ammonia can be turned black with a drop of sulphide of ammonia. It can therefore be seen how difficult it often is to prevent the formation of black or other coloured salts in the manufacture of sulphate of ammonia.

The author proceeds to examine more closely the materials brought into contact. They consist either of crude gas from which the tar has or has not been removed, or of ammonia vapours from distillation. The gas or vapours contain sulphuretted hydrogen and cyanogen, which bubble through the solution. When acidity of this decreases to such an extent that the slow circulation in the saturator gives an alkaline solution localized around the gas intake, or if there are obstructions due to the accumulation of salts through which the gas must make a passage, the result will be that the sulphuretted hydrogen and ammonia will act on the sulphate of iron crystals in the sulphate of ammonia, and produce a black precipitate of sulphide of iron.

The action of the gas is not limited to the formation of the sulphide, because, in presence of ammonia, this readily absorbs cyanogen. In such circumstances, the sulphide causes the formation of insoluble ferrocyanide of ammonia. Mixture of the two precipitates forms a black yellowish mass, which is hardly soluble in sulphuric acid, and which to a large extent constitutes the black matter that colours sulphate of ammonia. A very small quantity of this mixture in the sulphate turns it very black.

If, however, the precipitate is insoluble in sulphuric acid, it can become so in the portion of the solution which is made alkaline, owing to obstruction or slow circulation. Under the combined action of sulphuretted hydrogen and ammonia, a reaction occurs which results in the formation of a double soluble ferrocyanide of ammonia and insoluble sulphide of iron. The former can then be filtered through the salt crystals until it comes into contact with the acid portion of the solution, where the action of the sulphuric acid will again precipitate the single insoluble ferrocyanide of ammonia. The sulphuretted hydrogen, in presence of the sulphuric acid in the solution, can produce a sulphur precipitate which will mix with the sulphide of iron and insoluble ferrocyanide of ammonia to form the insoluble mass which blackens the sulphate.

This mixture of sulphur, sulphide of iron, and ferrocyanide of ammonia, constitutes a colouring matter with a tint varying from light yellow to deep black, and intermediately greenish yellow, by oxidation in the air. The chief cause of its formation is the presence of sulphate of iron in the sulphuric acid. A secondary cause is want of proper attention to the saturator, in which the acidity of the solution may have been allowed to decrease too much, or neutralization continued to such a point that the solution, having become very thick, causes local passages of ammonia vapours.

TAR AND LIQUOR.

By Dr. W. B. Davidson, of Birmingham.

[A Lecture Delivered to the Scottish Junior Gas Association, Western District, April 11.]

In previous papers I have already urged the necessity of taking proper account of the yield of tar and liquor, both in the valuation of gas coals and in the comparison of one carbonizing system or works with another. The importance of bringing these residuals into the reckoning depends not so much on their selling value on the gas-works (usually 25 per cent. of the total distillation products) as on the fact that, whereas it is exceptional to find two systems differing in gas production to the extent of 10 per cent., a difference of as much as 40 per cent. is sometimes found in the yield of tar, and as much as 20 per cent. in the yield of liquor.

Four gallons of tar, at 2½d. per gallon, are equivalent in money value to 1000 cubic feet of gas at 10d. per 1000 per cubic feet (cost price into holder, *plus* profit); and adding the value of six gallons of 10 oz. liquor at 0·8d. per gallon (say, 5d.), we get a sum of 1s. 3d. per ton of coal carbonized, or 1¼d. per 1000 cubic feet—representing the difference that sometimes exists in the income from these residuals between one works and another carbonizing the same coals. The gas production will rarely account for more than 10d. per ton of coal in modern plants; while the maximum variation in fuel will probably be no more than 6d.

Unfortunately the result of a year's working may, for manifold reasons, be very far behind what was anticipated; and it is a mistake to suppose that the returns of tar and liquor for a large works give a true index of the yields that are practically possible. For it must not be forgotten that where gas is lost through various causes—such as excessive pressure in the retorts, leaky retorts or retort fittings, uneven seals, delays in charging, and such like—tar and ammonia are also lost at the same time. A small proportion of tar may be converted into coke or carbon in partially stopped take-off or ascension pipes, or wasted as unsaleable pitch in the hydraulic main; while liquor is peculiarly susceptible to loss through exposure to air, imperfect washing, and leakage through pipe joints.

Obtaining the Highest Yield of Tar and Liquor.

To obtain the highest yield of tar and liquor, it is just as necessary to have the plant in perfect condition as it is for gas making. Further than this, of course, the engineer cannot go. The design of retort and retort-setting is responsible for the rest; hence the importance of paying proper attention to the all-round suitability of the retort-house plant. I believe there is a tendency to pay no particular attention to the production of tar and liquor, but simply trust to luck. Doubtless want of knowledge of what is attainable in this respect sometimes accounts for this indifference.

A coal-gas test plant must be of considerable size in order that it may be capable of ascertaining with satisfactory accuracy the yields of tar and liquor from a given coal. The carbonizing conditions having been made as perfect as reasonably possible, at least 50 tons of coal must be dealt with. At the beginning and the end of a test tar and liquor are drawn off from the hydraulic main, tar-tower, condensers, and washers to the wells, whence they are pumped to sales measuring tanks of suitable dimensions, where the liquid residuals are allowed to separate before measuring, sampling, and testing. Any ammonia passing the final washer is measured by test and allowed for—being added to the total. Particular attention must be given to the separation of tar from liquor, dipping or measuring, and sampling and testing. The tar should be corrected to a basis of 3 per cent. liquor by volume, and the yield of liquor increased or diminished accordingly.

Where retort plant is comparatively new, in good working order, and under careful supervision, the annual returns for tar and liquor may be taken as a fair criterion of what the system is capable of—due reference being had to the quality of the coals carbonized, which may differ from year to year. As a case in point, I may adduce the returns of a works where up till the end of 1909 direct-fired horizontal retorts were in use, distilling a charge of about 4¾ cwt. in six hours, at an average retort temperature at the time of discharge of 1600° Fahr., the normal charge for the particular size of retort at high temperatures being 6 cwt. In 1909-10 these old settings gave place to a well-known modern design of horizontal retorts of larger section, fitted with only one ascension pipe, and distilling 9⅓ cwt. in eight hours; the retort temperature at the time of discharge averaging about 1950° Fahr. The returns for the last few years, which are given below, speak for themselves.

—	1908.	1909.	1910.	1911.	1912.
Tar—actual (gallons per ton of coal)	12·32	11·45	9·60	9·18	9·34
Tar—actual (based on coal-test plant figures)	11·26	12·54	12·05	11·91	11·78
Difference, per cent.	+ 9·4	− 8·7	−20·3	−22·9	−20·7
Liquor—actual (gallons 10 oz. per ton of coal)	38·78	36·07	31·04	30·76	30·65
Liquor—actual (based on coal-test plant figures)	34·73	35·55	34·51	33·08	33·50
Difference, per cent.	+11·4	+ 1·5	−10·1	− 7·0	− 8·5

In the above instance the depreciation of the yield of liquid residuals has certainly not been due to leakage of gas through excessive pressure or bad working. The gas production of the new retorts has been most satisfactory—even excelling the coal-test plant by about 1 per cent.; but the reduction in income from residuals, amounting to about 1s. per ton of coal carbonized, nearly balances the gain in gas. The new type of plant therefore only justifies its installation by heavy reductions in fuel and labour costs, which much more than counterbalance the increase in capital charges and repairs entailed by the more elaborate regenerative settings.

Value of Comparisons.

It is thus evident that the whole truth about carbonizing results is essential to the formation of a correct opinion as to which works or carbonizing system is the more profitable. Gas production per ton of coal is not difficult to estimate with a moderate degree of certainty from week to week, and it is the custom in many undertakings to do so. In so far as this affords a comparison of gas-making results and necessitates frequent stock-taking, it serves a very good purpose, in that ready warning is given of a falling off, to whatsoever cause it may be due. This plan, however, leaves a good deal to be desired, not only when different carbonizing units are compared, but also when previous working of the same plant is considered; and it has the disadvantage of causing the engineer and manager and his committee to take a lopsided view of the results, and to favour systems which excel in gas only.

It is most difficult, almost impossible, to get reliable figures for tar and liquor week after week, unless special precautions are taken. The chief reasons for this are the heavy stocks that are usually carried, and the difficulty of determining the true line of demarcation between tar and liquor and the errors of measurement of wells and tanks, which are unfortunately as a rule not of sufficient depth, or small enough sectional area, to admit of accurate dipping, even in the case of sales tanks. The errors are minimized by taking special pains to measure accurately what is sold, by working with low stocks, and by separating tar and liquor as perfectly as possible by giving time for settlement and providing deep narrow tanks. Similar arguments apply to coke fuel used in the retort-house generators. The only satisfactory method of arriving at this figure is to subtract the coke sold from the total made; the latter figure being obtainable without difficulty. When stocks are very heavy, as they unfortunately are at present, the estimate can only be rough and ready.

The Monthly Return.

Whether the weekly comparison of gas results be made or not, it is to my mind very desirable that a proper and complete monthly return be made; and I would suggest that it includes tar and liquor as well as gas and fuel, on the following lines:—

Gas.—From the actual make per ton, reduced to standard temperature, pressure, and calorific value, is subtracted the corresponding test or recognized value computed for the particular mixture of coals carbonized. The difference, *plus* or *minus*, expressed in thousands, is multiplied by ten, or other agreed figure, to indicate the gain or loss in gas production in pence per ton of coal.

Fuel.—The weight of coke used for heating the retorts, as calculated by subtracting coke sold *plus* present stock from total coke made, *plus* previous stock, expressed as a percentage of the coal carbonized, is deducted from a recognized standard figure (say, 15), and multiplied by 1·5 or other figure (price of coke in pence per ton ÷ 100) to indicate the saving or loss in fuel. It would not be correct to base the result on a standard figure for coke sold, as different coals vary considerably in their total yield of coke. On the other hand, there are no great differences in the heating values of the cokes produced.

Tar.—From the actual yield in gallons per ton of coal is subtracted the standard test yield, and the difference, *plus* or *minus*, is multiplied by 2½, or other accepted figure denoting the value in pence per gallon of tar.

Liquor.—The actual yield in gallons (10 oz.) per ton of coal is compared with the standard test figure, and the difference, *plus* or *minus*, multiplied by the price in pence per gallon.

The algebraic sum of the four products will denote the gain or loss in distillation products, expressed in pence per ton of coal carbonized, or, by dividing by the make per ton (in thousands), the result can be expressed per 1000 cubic feet.

An example will serve to explain what is meant. Assuming that a certain coal or mixture of coals gives these results:

—	Test or Standard.	Works "A."	Works "B."
Gas, cubic feet per ton of 500 B.Th.U.	12,500	12,600	12,000
Fuel, per cent.	15	12	14
Tar, gallons	12½	9	13½
Liquor, gallons (10 oz.)	33½	30	36
Money Values.			
Gas at 10d. per 1000 cubic feet	—	+1·0	−5·0
Fuel at 1½d. per unit.	—	+4·5	−3·0
Tar at 2½d. per gallon	—	−8·8	+2·5
Liquor at 0·8d. per gallon	—	−2·8	+2·0
	—	−6·1	−3·5

In the value of the products of distillation the foregoing statement shows Works "A" to be inferior to Works "B" to the extent of 2·6d. per ton of coal carbonized, although the former produces 600 cubic feet more gas per ton. Abnormal charges for carbonizing wages, capital costs of retort plant, repairs to settings, &c., may, of course, be added or subtracted if thought desirable, though these items are more conveniently collected at the end of the year or half year.

Tar.

I propose to discuss the subject of tar more from the gas maker's point of view than that of tar distiller's. In these days of urgent demand for liquid fuels, which now command a good price, it is interesting to consider the enormous wastage of tar oils due to the consumption of coals in the United Kingdom for other than gas-making purposes. According to the Government Blue Book, 1912, the supplies of the United Kingdom amounted to 236,000,000 tons, of which the principal consumptions in percentages were:

Factories.	Domestic Use.	Iron Manufacture.	Mines.
23	14	12	7¾
Gas-Works.	**Railways.**	**Chemical-Works.**	**Metal-Works.**
6½	5½	2	½
Coasting Steamers.	**Steamers Overseas.**	**Exported.**	
1	7¼	20½	

A study of these figures leads us to the conclusion that at least 100 million tons of coal per annum could be displaced by coke, with the result that 1000 million gallons, or 5 million tons, of tar could be put on the market every year in addition to the 200 million gallons already there. If low-temperature carbonization were resorted to, the yield of tar could be still further increased to the extent of 30 or 40 per cent. It is well known that a large proportion of this tar can be used as liquid fuel. Crude tar made from Dessau retorts, for example, has been employed with success in Diesel oil-engines; and there would seem to be no reason why partially purified tar should not in a large measure take the place of mineral oil for heating purposes.

Yield of Tar under Varying Conditions.

The yield of tar is favoured by low retort temperature. For example, the following results were obtained with horizontal retorts in distilling 6 cwt. charges of a certain coal in six hours.

Retort Temperature. Degs. Fahr.	Tar. Gallons.
1630	12·7
1700	12·4
1775	12·1
1835	11·6

To take an extreme case—the manufacture of low-temperature coke resembling "coalite"—the respective conditions in carbonizing a Derbyshire coal were:

Retort Temperature.	Charge.	Tar.	Increase.	
Degrees Fahr.		Gallons.	Gallons.	Per Cent.
1920	6·5 cwt. in six hours	10·5	5·9	56
1250	5·7 cwt. in ten ,,	16·4		

In the above case there was, at the low retort temperature, half the normal make of gas; but it was 5 candles richer than usual. The coke still contained about 17 per cent. by weight of volatile matter as compared with 32 per cent. in the original coal.

Effect of Light and Heavy Charges on Yield.

By accelerating the rate of distillation—that is, by increasing the quantity of coal dealt with in a given time—the production of tar is increased at the expense of the gas. Thus:

Charge.	Duration.	Weight Carbonized Per Diem.	Tar.	Gas Multiple. Calorific Value Basis.	Retort Temperature.
Cwt.	Hours.	Cwt.	Gallons.		Degs. Fahr.
5·49	6	22·0	12·1	664	1915
6·48	6	25·9	12·5	640	1955
9·59	8	28·8	12·6	632	1980

It would appear that horizontal retorts fitted with only one ascension pipe produce a lower yield of tar than those fitted with two pipes; the gas production being somewhat increased. This was indicated by some tests carried out on the Birmingham coal-test plant a few years ago, which gave the following results:

—	Retort Temperature.	Gas Multiple	Tar.
	Degs. Fahr.		Gallons.
One ascension pipe	1805	621	11·1
Two ascension pipes	1815	613	11·7

Since then experience has been acquired with large installations of horizontal retorts having only one ascension pipe and working at temperatures, at the time of discharge, of 1950° Fahr. The yearly records of tar produced show a remarkable reduction with the advent of the new plant—accompanied however by an increase in gas production, also a large increment in naphthalene and in carbon bisulphide present in the gas.

Inclined Retorts.

It is remarkable that inclined retorts give a much more satisfactory yield of tar than horizontal retorts having one ascension pipe. The following are the returns for a large installation of inclined retorts for a number of years, with the standard test figures obtained with horizontal retorts having two ascension pipes, calculated on the same coals. The inclined retorts in question have one ascension pipe—at the lower end—and are heated to nearly as high a temperature as the horizontal retorts of the large installations referred to.

—	1909.	1910.	1911.	1912.
Inclined retorts	11·57	11·34	11·66	11·53
Horizontal retorts—				
Two ascension pipes, test plant.	12·42	12·23	12·12	12·12
Reduction per cent.	6·8	7·3	3·8	4·9
Reduction in horizontal installation with one ascension pipe, per cent.	..	20·3	22·9	..

The question arises, Which is the more profitable method of working? The chief consideration in settling this is the relative values of tar and gas. Under present conditions, one might say a gallon of tar is equivalent to 250 cubic feet of gas.

Vertical Retorts and Coke-Ovens.

These produce a high yield of tar—probably rather more in the intermittent design than in the continuous. Coke-ovens are intermediate in their yield between verticals and horizontals. In any case it is possible to provide sufficient cracking space to reduce the yield of tar to the usual figure, or for that matter to reduce it to very low limits. At the present respective prices of tar and gas, it is usually much more profitable to refrain from cracking the tar to an abnormal extent.

In order to investigate the possibilities of converting the tar into rich gas, experiments were carried out on a small oil-gas plant, ordinarily used for the testing of 1-gallon samples of carburetted water-gas oil, with the following results:

One Gallon of Tar from Dessau Verticals.

Temperature of Oil-Retort.	Gas.	Illuminating Power.	Multiple.	Value of Gas.
Fahr. 1580°	Cubic Feet. 68·1	Candles. 17·35	1182	Pence. 0·8

One Gallon Distillate from Above Tar.

1495°	72·3	21·90	1586	1·1

One Gallon Gas Oil for Comparison.

..	75	40	3000	2·0

The gas from the tar distillate contained 0·38 per cent. of H_2S and 1·38 per cent. of CO_2 by volume, and 19 grains of sulphur per 100 cubic feet.

In cracking the tar, the retort had to be opened twice to relieve blockages in the tar feed-pipe, thereby adversely affecting the test. There is no doubt that better results could be obtained by suitable alterations in the design of the oil-gas plant; but, on the face of it, there would seem to be no inducement to convert tar into gas.

Quality of Tar.

It is well known that the composition of tar varies considerably with the kind of retort and the carbonizing temperature employed. The following analyses of samples of tar obtained from the Birmingham Gas-Works and test installations may be found useful for the purpose of comparison. They were carried out on 200 c.c. of tar in a ½-litre Jena glass fractionating flask, with the bulb of the thermometer placed just below the side tube. Of the 150 samples tested, the volume percentage of ammoniacal liquor present varied from 1 up to as much as 12 (when the tar had not settled well); the average being about 3. The figures in the tables [p. 111] are reckoned on the dry basis, and indicate volume percentages, except in the case of free carbon, which is by weight. The temperatures are in the Centigrade scale.

The foregoing representative analytical tests indicate that low-temperature carbonization favours low specific gravity, low free carbon content, low yield of pitch, and high content of light and middle oils.

Heavy charges have a similar effect. High temperatures or light charging result in a high-gravity tar, high in carbon and pitch. Dry main working appeared to have a prejudicial effect on the tar in the same direction.

Pitch Troubles.

It will be seen that tar from vertical retorts is low in gravity, free carbon, and pitch, but high in middle oils, as compared with tar from horizontal retorts. In spite of these advantages, pitch troubles are much more frequent with the former type of plant

Works Samples from Sales-Tanks.

Conditions.	Specific Gravity.	Free Carbon.	Up to 100°.	100° to 130°.	130° to 170°	170° to 230°.	230° to 270°.	270° to 330°.	Above 330° (Pitch).
Horizontal Retorts. Two ascension pipes, charges 5¾ cwt. in six hours, 1800° Fahr.	1·182	16·4	1·4	1·9	0·3	14·7	9·5	11·3	60·9
Horizontal Retorts. Two ascension pipes, charges 6½ cwt. in six hours, 1950° Fahr.	1·191	20·3	2·1	1·3	0·1	12·5	10·8	8·1	65·1
Horizontal Retorts. Two ascension pipes, charges mostly 12 cwt. in twelve hours, 1900° Fahr.	1·129	13·9	2·0	0·6	0·4	18·9	12·8	13·6	51·7
Horizontal Retorts. One ascension pipe, charges 9½ cwt. in eight hours, 1950° Fahr.	1·200	20·2	1·5	0·7	0·8	12·7	11·1	8·5	64·7
Inclined Retorts. One ascension pipe, charges mostly 6 cwt. in six hours, 1900° Fahr.	1·176	19·4	2·0	0·7	0 4	15·1	11·2	11·4	59·2

Coal-Test Plant Experiments.

Conditions.	Specific Gravity.	Free Carbon.	Up to 100°.	100° to 130°.	130° to 170°.	170° to 230°.	230° to 270°.	270° to 330°.	Above 330° (Pitch).
Horizontal Retorts.									
Coal "A" (Derbyshire)—									
(1) Coalite Conditions	1·120	7·6	3·7	3·2	0·1	18·4	10·9	13·2	50·5
(2) Ordinary conditions, 6·4 cwt. in six hours, 1980° Fahr.	1·190	19·1	1·5	1·5	0·4	10·9	10·7	10·3	64·7
Coal "B" (Yorkshire)—									
(1) 4·54 cwt. in six hours, 1640° Fahr.	1·160	—	12·7	2·1	1 6	4·8	16·1	12 5	50·2
(2) 4·87 cwt. in six hours, 1975° Fahr.	1·234	27·5	3·5	1·1	0·8	7·9	7·3	7·6	71·8
Light and Heavy Charges.									
Coal "C" (Derbyshire)—									
(1) 6·41 cwt. in six hours, 1980° Fahr.	1·190	19·1	1·5	1·5	0·4	10·9	10·7	10·3	64·7
(2) 12·21 cwt. in twelve hours, 2065° Fahr.	1·150	15·9	1·9	1·6	0·4	17·1	11·4	15·5	52 1
Coal "D" (Derbyshire)—									
(1) 6·52 cwt. in six hours, 2020° Fahr.	1·211	23·8	1·7	2·7	0·0	8·9	10·0	7·7	69·0
(2) 9·59 cwt. in nine hours, 1980° Fahr.	1·151	15·5	3·9	3·2	1·4	14·1	10·2	11·5	55·7
Coal "E" (Derbyshire)—									
(1) 6·49 cwt. in six hours, 1990° Fahr.	1·177	20·5	2·4	5 1	0·3	13·2	12·0	7·8	59·2
(2) 13·41 cwt. in twelve hours, 1990° Fahr.	1·107	—	1·6	0·8	0·1	21 7	11·0	14·2	50·6
Wet and Dry Main.									
Coal "F"—									
(1) Wet Main, 6·41 cwt. in six hours, 1980° Fahr.	1·190	19·1	1·5	1·5	0 4	10·9	10·7	10·3	64·7
(2) Dry Main, 6·51 cwt. in six hours, 1980° Fahr.	1·210	27 7	0 7	0·6	0·5	8·0	9·1	5·2	75·9
Coal "G"—									
(1) Wet Main, 6·41 cwt. in six hours, 1920° Fahr.	1 158	18·9	2·9	0·7	1·2	14·5	9·8	11·8	59·1
(2) Dry Main, 6·35 cwt. in six hours, 1965° Fahr.	1·215	26·8	1·0	0·9	0·4	8·6	8·7	10·2	70·2
Poor and Rich Coals.									
(1) Derbyshire, 6·23 cwt. in six hours, 1990° Fahr.	1·190	24·6	1·4	0·9	0·2	12·2	10·3	10·9	64·1
(2) Yorkshire, 6·49 cwt. in six hours, 2025° Fahr.	1·229	28·4	1·6	1·0	0·3	19·2	9·1	7·9	69 9
(3) Wigan Cannel, 5·74 cwt. in six hours, 2040° Fahr.	—	11·4	4·6	3·9	1·4	5·2	8·9	4·6	71·4
Dessau Vertical Retorts.									
(1) Coal "H" (Yorkshire)	1·114	4·47	0·6	0·4	0·4	12·0	10·7	13·1	62·8
(2) Horizontals for comparison, 6·44 cwt. in six hours, 2070° Fahr.	1·216	25·8	1·7	1·4	0·1	10·0	9·2	7·9	69·7
Woodall-Duckham Vertical Retorts.									
(1) Coal "I" (Derbyshire)	1·110	3·8	1·7	2·9	0·5	12·2	11·8	8·6	62 3
(2) Horizontals for comparison, 6·41 cwt. in six hours, 1980° Fahr.	1·190	19·1	1·5	1·5	0·4	10·9	10·7	10·3	64·7

than with the latter. The conditions causing these difficulties form an interesting study.

The gas leaves the horizontal or inclined retort at a fairly high temperature, and ascends a long pipe, 6 to 8 inches in diameter, where it undergoes rapid cooling; depositing a certain amount of pitch during the early stages of distillation of the charge of coal. This pitch has a tendency to harden, accumulate on the sides of the pipe, and eventually coke by the action of the hotter gases evolved during the later period of distillation. The result is a stopped pipe, which has to be cleaned by augering with hard labour.

If the coal forms a large quantity of steam, or if the pipe is kept sufficiently cool by dribbling water down from the H pipe, the stoppage may be prevented; but in that case there is generally an accumulation of tar at the bottom of the pipe, and the ammoniacal liquor is weakened. In any case, however, the gas will reach the hydraulic main at a temperature of about 170° to 200° Fahr. and will begin to deposit both tar and liquor, owing to the further cooling it is there subjected to. If the gas leaves the hydraulic main, as it generally does, at not more than 150° Fahr., the condensation of tar will have been copious enough to prevent pitch forming to any great extent. The proportion of virgin liquor thrown out at this temperature will be small, as the dew-point of crude gas is rarely much above 160° Fahr.; but it will suffice to prevent a deposit of solid ammonium chloride.

In the case of vertical retorts and coke-ovens as usually designed, the gas reaches the hydraulic main at a high temperature; and whether a dry or wet main be in use, with or without dip pipes, a quantity of pitch condenses out and settles to the bottom of the main, where it accumulates and finally stops gas-making operations, unless special means are employed to remove it—either by fishing it out in lumps at the end of the main, or else by means of pitch pans at the bottom of each dip-pipe. If the hydraulic main is excessively hot—say, above 500° Fahr.—and the foul main is not of sufficient diameter to provide large enough condensing surface, or is not designed with proper fall, an accumulation of pitch may take place in the latter. This is apt to arise in coke-oven working where, owing to the long periods of distillation, the final gases leave the oven at very high temperature, and, passing over the tar deposited in the foul main, distil the same; leaving behind hard pitch, sometimes partially coked, mixed with ammonium chloride. The layer of pitch, once formed, is difficult to redissolve; and if its presence is not suspected and steps are not taken to remove it by means of fire buckets and a circulation of thin tar, the main will gradually fill right up until an unworkable back-pressure is set up, necessitating drastic remedies.

The longer the thick tar or pitch remains at a high temperature in an ascension pipe or take-off pipe, hydraulic main, or foul main, the worse it becomes, owing to the fact that it gets less soluble, either by producing free carbon or by partially coking. This deterioration is noticeable in distilling a sample of tar in a glass vessel. For example, 200 c.c. of tar from a continuous vertical retort installation left a residue distilling above 330° C., of 66 per cent. of pitch by weight. This residue was found to contain some 10·55 per cent. of free carbon, whereas the original sample only contained 3·8 per cent. In this case the heating of the tar increased the total quantity of free carbon by 83 per cent.

A sample taken from a foul main that was two-thirds full of hard pitch gave on analysis 34 per cent. of free carbon and 13 per cent. of ammonium chloride.

Another source of trouble is the fixed salts, chiefly chloride, which leave the retort as vapour, dissociate into ammonia and acid, and come together as a solid sublimate when the gas cools down to the neighbourhood of 200° Fahr. At this temperature no liquor is formed, and the chloride remains in the solid form. A current of hot gas carrying carbon and fine powdery crystals of ammonia salts deposits the solid matter, when sufficiently cooled, where it is first baffled; and thus it happens that retort-house governors and connections are a danger zone for blockages.

It is not a difficult matter to clear away any salts of ammonia with sprays of hot water or gas liquor. The chief dangers arise from the difficulty of locating the exact spot where the accumu-

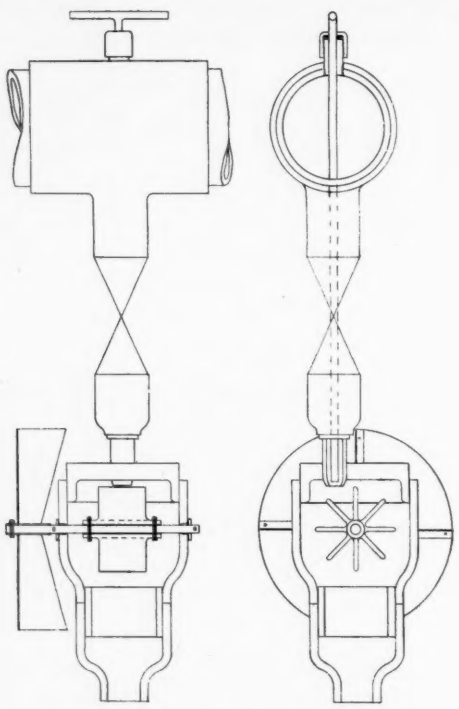
lation is taking place, and from the fouling of the bye-pass and governor valves. When condensation takes place in a large foul main to such an extent that virgin liquor is formed, there need be no cause for anxiety.

In modern retort plants, such as vertical retorts and coke-ovens, the conditions in the hydraulic main or its equivalent call for careful study. Here the gas is hot enough to boil off any liquor in the main, leaving salt behind. It may even, under favourable conditions, distil the tar itself, producing pure pitch. If a liquor seal is used, the formation of solid chloride is prevented; but as the tar beneath the liquor is too heavy, too cool, or not well enough agitated to dissolve the pitch that drops from the dip pipes or otherwise collects in the hydraulic main, one must be prepared to have pitch pans under the dip pipes, or in some other way, at least once or twice a week, fish out lumps of pitch. If you prefer to work with a tar-seal by running in a continuous stream of tar, in the first place you will find it difficult to maintain anything like a constant seal, on account of the lack of uniformity in the consistency of the tar and occasional banking-up and blockage of the overflow, and you will still have more or less pitch nuisance. Again, it is a very awkward problem to regulate and maintain without intermission a proper supply of tar to the main.

Experience with Dessau Verticals at Birmingham.

In so far as it bears on this point, it may interest you to hear a short account of our experience with a new installation of fifteen beds of Dessau vertical retorts (1912 model) at Nechells, Birmingham. It was recognized from the first that it would be most satisfactory to work without a seal and with a stream of tar flowing at the rate of about 120 gallons per hour through each hydraulic main. [There is a separate hydraulic main to each bed; the capacity of a bed being 17 tons of coal per diem.] At the outset a few days' trial was given to the liquor seal, and afterwards to the tar-seal—with unsatisfactory results, however.

Recourse was then had to an "anti-dip," with a good supply of tar. Two difficulties arose. On the one hand, it was found necessary to employ considerable additional labour to assure a constant flow to each main, as the jets and cocks frequently became blocked. On the other hand, the open syphons or bent pipes leading the tar down the ascension pipes which connect the hydraulic main with the foul main sometimes became choked,



Tar-Jet Indicator.

overflowed, and gave rise to alarming fires. After experiencing three or four fires, one of which damaged the top wooden platform and electric cable, we decided to close the syphons, and, after a few trials, hit upon the fairly satisfactory arrangement shown in accompanying sketch. The filtering of the tar on the suction of the pumps, as well as in the large overhead tank, further improved matters very much.

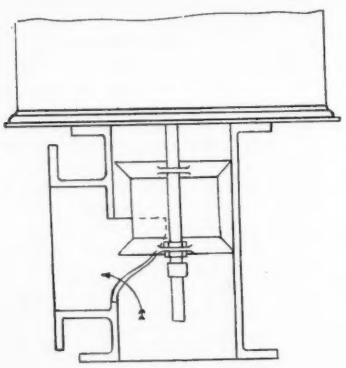
Even with the aid of these devices tar-jets require a good deal of attention; and it was with a feeling of relief that we made the discovery that a continuous supply of tar was unnecessary; the present procedure adopted being as follows: A few minutes before the draw, which takes place every six hours (nine retorts in the bed of eighteen being charged at one time), the hydraulic main is filled with tar so as to give ½-inch seal on the dip-pipes. The tar in the main is then 10¼ inches deep. A slow-moving rocking agitator works continuously in the hydraulic main, which is of the standard Dessau pattern, but with the diaphragm plate removed. One small motor drives the agitators for five beds in each of the three ranges.

When charging is completed the seal is removed, and the level of the tar in the main brought down, by means of a special valve in the overflow box, to the normal working height of 4 inches. At the end of six hours, the main is again filled with tar for 15 or 20 minutes, and so on. The 6½ inches depth of tar added every six hours, amounting to about 100 gallons, mixes, under the influence of the stirrer, with the hot, heavy tar or pitch previously in the main, and thins it out. After the surplus is run off, the pitch dropping from the dip-pipes or directly out of the gas is readily taken up by the tar and kept in homogeneous solution by the agitator. The hot gases passing over the continually changing surface of the tar distil off the oils; and the result at the end of the six hours is a slight reduction in volume and the production of about 30 gallons of pitch, which, at the high temperature in the hydraulic main (350° Fahr.) is quite liquid and gives no trouble, but on cooling to ordinary temperature is solid. Though this has not yet been put absolutely to the proof, there seems to my mind a good prospect that in this way the partial fractionation of the tar by the sensible heat of the crude gas can be accomplished satisfactorily in a very simple manner in all vertical retort and coke-oven installations.

The Feld Process.

This was one of the aims of the late Herr Walther Feld, by whose lamented death last month the gas industry has lost one of its most original and brilliant inventors. His process, as you will remember, consisted in treating the hot gas coming from the foul main at 170° to 200° C. in one of his centrifugal washers, where the gas, in cooling to 160° C., deposited tar constituents having a boiling point of 300° and over—160° being approximately the dew-point of the high boiling substances that constitute pitch. In a second washer the temperature was lowered to 80° C., when another fraction separated out, the lowest boiling point of which was 180° C. In the third washer, light oils and water were condensed. The process was tried some years ago, but without achieving success, so far as I have been able to ascertain. The hydraulic main method is much simpler. In the first place, it dispenses with the quite considerable amount of labour usually bestowed on clearing the mains from pitch; and on this ground alone the agitator is worth while installing. In the second place, the pitch can be varied in hardness at will, according to market requirements, by altering the depth of the tar in the main or the period under action of the retort gases. The removal of practically all the pitch, free from ammonium chloride and otherwise pure, direct from the hot gas-main is calculated to reduce the tar-distiller's expenses by about one-half, and thus the gas undertaking ought to receive a correspondingly higher price for its tar. The agitator was installed, however, not with the idea of manufacturing pitch for sale, but in order to prevent pitch troubles.

Excessive vacuum is to be avoided. The take-off pipes are cleaned by discs once every day or two days four to six hours after charging, when the pitch on the pipe is soft. Under these conditions very little dirt gets into the hydraulic main. When a pull of ½ inch or more is exerted on the retorts for any length of time, air and furnace gases are drawn in, there is sometimes partial combustion of the gases leaving the retorts, owing to access of air, the take-off pipes become very hot—in aggravated cases, red hot—and even the hydraulic main itself may become red hot. Under these conditions, the tar in the main becomes not merely pitched, but coked. Good governing is therefore essential. If a retort-house governor is required in addition to the ordinary exhauster, the old type of cylindrical slotted valve should be avoided for use with crude gas of temperatures above 180° Fahr., as it very readily blocks up. The accompanying sketch shows a type of valve which we have found to work satisfactorily.



Retort-House Governor Valve.

Liquor.

After the gas leaves the hydraulic main, there is no question about recovering all the tar that it contains; but it is quite a different problem with ammoniacal liquor. This has to be carefully looked after week by week, and any shortage investigated. As already stated, however, it is difficult to obtain accurate stock-taking more often than once a month. Open dribbles of liquor feeding hydraulic mains, overflow troughs from tar-towers, open

syphon liquor feeds to primary washers, imperfectly covered wells and tanks, defective pipe jointing, and corroded pipe lines, are all sources of loss.

Tests carried out with a small bosh, 42 in. by 24 in. by 21 in. deep, full of ordinary 10 oz. liquor, with the top open but protected from rainfall, showed an average daily loss in strength of $1\frac{3}{4}$ per cent., at a mean daily temperature of 50° Fahr. In cases where light tar oils were present, the rate of evaporation was much reduced owing to the protection afforded by the film of tar.

It is well known that different methods of carbonizing produce widely different results in yield of ammonia, and that the retort temperature must be neither too low nor too high to give the highest production. The following results, obtained on the Birmingham test plant of horizontal retorts, were published a few years ago.

Charges—6 cwt. in Six Hours. Same Coal Throughout.

Retort Temperature.	Gallons 10 oz. per Ton of Coal.
Degrees Fahr.	
1630	43·1
1700	42·8
1775	40·4
1855	41·8

Under coalite conditions, another coal gave a yield of 24·8 gallons (10 oz.) as compared with 35·4 at ordinary temperatures.

An example of remarkable reduction in works returns for liquor through the modernizing of the retort plant has already been instanced. Examples are common enough where the yield of liquor diminishes year after year owing to defective plant or want of supervision. Though the handling of ammoniacal liquor requires special care, there is no serious difficulty, with proper design and supervision of plant, in restricting losses to a reasonable figure.

Simple Testing Apparatus for Tar and Liquor.

Finally, I take the opportunity of bringing to your notice a few simple appliances which I have found very convenient and accurate in the testing of tar and liquor. The accompanying sketches require little description. Fig. 1 shows a tar-testing tube. The wide portion is filled with dry cotton wool or carded asbestos fibre, and weighed. It is then connected with the narrow tube by means of a ground joint, placed well into the gas-main and connected with the gas-meter. After sufficient gas has passed, the wide portion is dried in a desiccator or in a current of air or gas, according to conditions, and again weighed to ascertain the weight of tar collected. For Mond gas a plug of wool is insufficient. It is necessary to remove the last trace by washing with alcohol or ether.

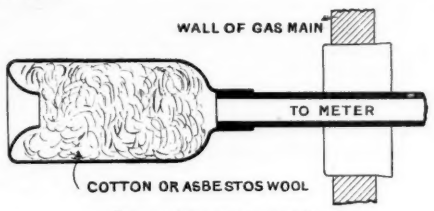


Fig. 1.—Tar-Testing Tube.

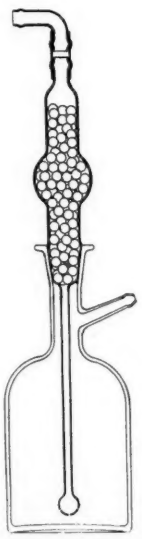


Fig. 2.—Ammonia Testing Apparatus.

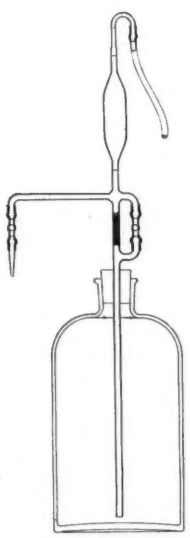


Fig. 3.—Standard Pipette.

Fig. 2 is a convenient form of apparatus for testing quantitatively for ammonia passing the washers. A small quantity of water is first introduced into the bottle, so that the perforated bulb is just sealed, and 25 c.c. of normal sulphuric acid are carefully introduced at the top of the glass bead scrubber. For this and similar purposes, I recommend the standard pipette shown in fig. 3. This, operating by means of small glass ball-valves, is exceedingly accurate, and saves much time. After the proper quantity of gas has passed through the washer-bottle at the rate of about $\frac{1}{2}$ cubic foot per hour, the contents of the scrubber tube are carefully washed-down with distilled water into the bottle, where the titration is directly made against normal soda, with methyl orange as indicator. If the amount of acid used up is likely to be small, as at the outlet of the final ammonia washer, it is advisable to titrate back first with 20 c.c. of normal soda delivered from a standard pipette, and to finish off with decinormal soda from the standard burette (fig. 4).

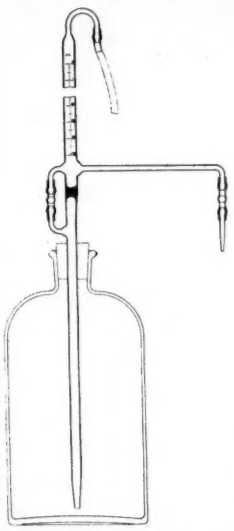


Fig. 4.—Standard Burette.

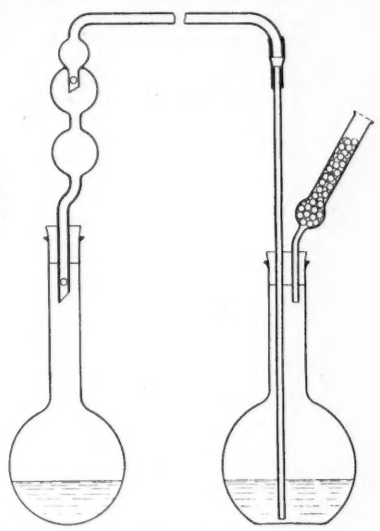


Fig. 5.—Ammonia Liquor Testing Apparatus.

A liquor-testing apparatus is shown in fig. 5. A round-bottomed Jena glass flask of 400 c.c. capacity is used as the still into which 20 c.c. of liquor are carefully delivered by pipette. About 100 c.c. of 5 per cent. solution of caustic soda are added. The receiver is a Jena flask of 750 c.c. capacity, with an ordinary flat bottom, and is fitted with a two-holed rubber stopper carrying a long, straight narrow tube and a short scrubber. Into the receiver 50 c.c. of normal acid are introduced, together with about 100 c.c. of distilled water. The connections are then made as indicated in the diagram; a special form of anti-splash still-head being used. The contents of the still are boiled down steadily till only about 40 c.c. remain. The rubber tubing is disconnected while under pressure. The contents of the receiver are cooled-down and titrated, as in the last-mentioned test. If the liquor strength is less than 19 oz., it gives greater accuracy to titrate the acid back first with 20 c.c. normal soda measured from the standard pipette, and finish off with fifth or tenth normal soda.

LIGHTING OF RAILWAY CARRIAGES.

Wherever artificial illumination is employed, there the Illuminating Engineering Society finds work and scope for investigation. At its last meeting, Mr. E. Kilburn Scott read a paper on the subject of the lighting of railway carriages and other public vehicles; but, under the written and unwritten laws of the Society, he had to keep off all controversial ground in regard to the respective advantages and disadvantages—including such points as installation and running economy, reliability, glare, and diffusion. Mr. Leon Gaster presided, in the absence of the Chairman of the Council (Mr. F. W. Goodenough); and he kept those who took part in the discussion rigidly to a commercial impartiality.

As Mr. Scott pointed out, the lighting of the means by which we travel is a matter of great importance in these fast-moving days; and the manner in which lights are arranged, and the eyes of the public are protected in railway coaches and elsewhere is a matter of considerable moment—in view of the large amount of time spent in travelling. He finds that in the last ten years there has been a great improvement in the lighting; and yet he submits there is still much to be done. He admits that the introduction of the inverted mantle, with its economical consumption, compact form, and improved durability did a great deal for gas in connection with train lighting; and similarly the metal filament lamp has made electric lighting practicable where otherwise it could not have been used. In modern carriages the illumination is much in advance of what it was a few years ago. In the gas-lighted coaches, the mantles usually adopted are rated at about 30-candle power, whereas electric incandescent lamps are mainly 10-candle power ones at 22 volts; three of these being not infrequently used for an ordinary third-class carriage. When the electricity has to be generated on the train, the size, output, and initial cost of the plant, especially the battery, sets a limit to the light employed. Where on railways electricity is obtained from

an external supply, lamps of much higher candle power can be employed; and in these circumstances the illumination is considerably higher than in steam-driven trains. One advantage of self-contained systems of lighting is the comparative constancy of the light. On tramways and tubes, the fluctuations may be trying to the eyes. On most of the railways there is a decided diminution in the electric light as the train is starting-up, and a heavier current is taken. This point was investigated by Professor J. T. Morris some years ago; and he gave an interesting diagram showing the variation in illumination from station to station on the Central London Railway. The diagram was shown on the screen; and the variation was very marked. Reference was also made to the discomfort of temporary total extinctions of light.

The next point touched upon was the vibration or tremors to which the lamps are subjected. This was an objection to the upright incandescent mantle in railway carriages; but through the inverted mantle and its method of suspension, the incandescent gas system became feasible for railways. When metal filament lamps were first introduced, the fragility of the wire was a drawback. A curious fact mentioned by one railway engineer was that the lamps seemed to give way at night while the carriages were standing. On taking out a train in the morning, the driver would find that quite a number of filaments were broken. The manufacture of the filament has, however, been rapidly improved; and at the present time metal filament lamps are used on most of the underground railways—five 100-volt lamps being run in series. For steam-train lighting, the pressure is only 24 volts; so that thicker filaments are possible, which is, of course, a distinct advantage. The 10-candle power 24-volt lamps usually employed consume 1·3 watts per candle power, and have an average life of about 900 hours, which is approximately the number of lighting hours for an average running railway coach in a year.

As to the placing of the lamps, Mr. Scott says it is better to space several lamps over the roof of a compartment than have a single central light. With a white ceiling, to diffuse the rays, a moderately good illumination is obtained. Direct light, the author holds, is not convenient, because the light strikes at an oblique angle whatever one is reading. He suggests semi-indirect lighting; so as to get the light reflected in many different directions. With a white ceiling (which should be dead-white, and not shiny-white) and good diffusing globes, this method may be recommended. The engineers connected with railways and traffic companies are usually quite aware of the desirability of getting a soft light, and using proper methods of shading; but directorates apparently require to be educated. From the standpoint of reading, there is much to be said for bracket lighting, providing means are taken to prevent glare in the eyes of travellers on opposite seats. It is interesting to note that at one time a royal saloon in India was used by Lord Curzon; and he complained that he could not read. By shading the central cluster with a suitable enamelled reflector, the illumination was brought up to a satisfactory value. This shows how important it is that either the roof should be painted white, or lamps should be provided with suitable reflectors. The sombre tints habitually used for the cushions in railway carriages in this country absorb a good deal of light; and it would be much better to use somewhat lighter tints, as is more general in other lands. A light ceiling makes the glare from an unshaded light much less noticeable. A bright object, seen against a light background, does not appear nearly so dazzling as it would do if the surroundings were black; for glare is largely a matter of contrast. However, the author says that the time must be surely coming when passengers will be no longer satisfied with rows of glaring lights right in the line of vision.

As to the amount of illumination desirable, it would appear that there is now little difficulty in obtaining 2 foot-candles; and as this is the minimum prescribed by the Joint Committee on School and Library Lighting, Mr. Scott considers that the illumination of public vehicles should not be less. People habitually read when they are travelling; and the conditions of illumination provided influence a passenger in selecting his route, especially if he is bound on a long journey. Mr. Aspinall, of the Lancashire and Yorkshire Railway, has stated that it costs roughly four times as much to heat a carriage as to light it. Even with the best lighting, the cost is but a trifling percentage of the total running cost per mile; and this is amply repaid by the gain in patronage from the public.

The discussion was in several respects a somewhat straggling one; the best contributors were undoubtedly Mr. J. S. Dow and Mr. V. H. Mackinney. The Chairman (Mr. Gaster) thought it was the duty of railway companies to give an amount of illumination that would ensure real comfort in reading; and to-day there was no hardship on the companies having to supply a right minimum. In his remarks, Mr. Dow described actual illumination tests that he had made on different railways in fairly typical carriages. He took his measurements on the horizontal plane at knee level. On the Great Western Railway the inverted gas-lamps (25-candle-power) he finds are placed centrally in the carriage. The objection to this is that in a large carriage the light is not equal in all parts. Equal lighting is obtained much better with a distributed system. In the case of a saloon carriage, however, with three gas-lamps (enclosed) down the centre of the white roof bay, more even illumination was found. In this case the illumination was equal to 4 foot-candles, which Mr. Dow says is "quite good value." In the compartments of a corridor carriage, the lamps were not placed centrally, with the result that at one end 3·5 foot-candles were obtained and at the other end 2·5 foot-candles. Where an illumination of 4 foot-candles was given, he suggests that it would pay to screen-down the light, because the light source giving such a high illumination is rather a brilliant one to look at. In a saloon carriage that was lighted electrically, with the lamps concealed in globes etched on the inside and polished on the outside, the illumination was equal to 2½ foot-candles. The effect was quite soft; much better than a bare lamp in a clear globe. With two lights centrally placed in a third-class carriage, the illumination in one corner dropped down to 0·6 foot-candle. With three lamps arranged across the compartment, the illumination measured at the ends and centrally was 1·3 foot-candles (end), 1·5 foot-candles (centre), and 1·4 foot-candles (end). On the Great Eastern line, the first-class carriages are fitted with three lights, and the second-class, with two lights. With gas-lighting, a central 25-candle unit is employed. On the South-Western line, the practice is to have lamps of the total value of 32 candles per compartment in the case of electricity; and in the case of gas-lamps, a single unit rated at 40 candles. In special suburban first-class carriages, bracket lights are used of a candle power running up to 60 candles. The candle power in the carriages of this Company has doubled in the last six years. Mr. Dow also suggests that where 1 foot-candle can be obtained at knee-level, the probability is that nearly 2 foot-candles would be secured when the paper or book that is being read is lifted up. This would not be very far from the figure recommended by the Society's Joint Committee for the lighting of schools and libraries. The illumination named is one that would add to the comfort of passengers.

A contribution to the discussion was made by Professor Morris. On the point of glare, he thinks that if the companies could afford to use half or three-quarter frosted globes or bulbs, it would be the best plan; but this would not be necessary with some form of shade, or with a white background. He also referred to the variations of light that he has found on the underground railways of London; and also to the sudden changes and flickerings that are sometimes experienced, which are very trying indeed to travellers. Mr. Ives showed an anti-vibrator device designed by Mr. Haydn Harrison, which is used for factory lighting, where the vibration of machinery tends to break the filaments of electric lamps. The contribution of Mr. Ives did not seem to have much about it pertinent to the subject of train lighting. Mr. Mackinney does not think that semi-indirect lighting is suitable for railway carriage illumination, as there must be a reasonably low drop for the fitting in order to give a sufficient illuminating value for the energy consumed. Mr. Scott on paper depicted the beautiful distribution of light that could be obtained by the semi-indirect system in railway carriages; but such is not the case in practice. Where there is sufficient height, there is a well in the ceiling; and with semi-indirect units in this well, the light would be lost. Direct lighting, properly applied, has good points about it. A bracket light behind one is an excellent arrangement, if it can be so fitted that the person opposite has not his eyes offended by it. Another speaker protested against the exposure of lamps of high intrinsic brilliancy to the eyes of passengers; while another speaker, who appears to prefer sleeping to reading in railway carriages, also had a little grumble. A voluble speaker who followed roamed over all sorts of topics referring to illumination; his fund of knowledge appearing to be composed of things that we have all heard of before, and the fund (such as it was) seemed inexhaustible. Whether it was a nod from the Chairman or something else we do not know; but the speaker, after he had had a good innings, had it forced upon him that the audience desired to hear Mr. Scott in reply, and to retire for the night. Mr. Gaster summed up, referring to the considerable progress that had been made in the lighting of railway carriages. The lines of improvement are reduction of flickering to a minimum, adequate illumination, the application of satisfactory shades, and the avoidance of dangerous ones. In his reply, Mr. Scott held that it is not right that, in the means of public transit, the eyes of passengers should be exposed to such a variation of illumination as is now experienced, as (say) between the tube lines and some of the suburban ones.

Italian Gas Companies' Reports.

The Società Italiana Per il Gas held its annual meeting on the 19th ult., and from the report of it we take the following figures:

Town.	Gas Sold. 1912. Cubic Metres.		Gas Sold. 1913. Cubic Metres.
Turin	24,403,395	..	25,040,019
Bergamo	1,867,731	..	1,678,067
Tortona	463,984	..	439,480
Girgenti	541,765	..	555,305
Venaria Reale	65,694	..	78,001
Total	27,342,569	..	27,790,872

The increase at Turin amounted to 2·6 per cent. At the Borgo Dora works in Turin a new bench of six beds of vertical retorts was put in operation last winter. The Società Italiana per l'Industria del Gas (Milan) sold during last year 10,148,768 cubic metres of gas; being a very slight reduction on the previous year—due to temporary causes. The Società at Ferrara shows a small increase; the year's sale of gas amounting to 1,841,211 cubic metres.

THE DETERMINATION OF SPECIFIC GRAVITY BY MODERN METHODS.

By Dr. Leonard Levy, M.A. (Cantab.), F.I.C.

Much has appeared from time to time in the Technical Press regarding the determination of the specific gravity of gases—a subject of great importance to gas engineers, owing to its bearing upon questions both of manufacture and of distribution.

This note does not purport to give any general account of the methods and apparatus employed for this determination; the intention being rather to endeavour to explain (according to the author's view) the theory of some of the most recent instruments which have been devised for this purpose. The author is led to give this explanation because it is within his experience that the *modus operandi* of these specific gravity instruments is rarely properly understood, and numerous communications have come to his notice, from various quarters, which clearly show that the action of some of them is totally misapprehended. A short theoretical explanation of the effusion tests for the measurement of specific gravity and of the Lux balance, and a full explanation of what the author believes to be the correct theory of the gravitometer, are given in the sequel.

The Effusion Test for Specific Gravity.

The effusion tests of Bunsen and Schilling, and the Simmance-Abady specific gravity bell, are instruments whereby specific gravity is determined by comparison of the rate of effusion through a very small orifice. [It should be noted that the term "diffusion" is also incorrectly applied to this phenomenon.]

(1) The general equation for the effusion of gases from a small orifice, as deduced from the kinetic theory of gases, is

$$P = \tfrac{1}{8}\pi\rho v^2,$$

where P is the pressure, ρ the density of the gas, and v the mean speed of its molecules.

Hence, for two different gases under the same pressure P, we have $\tfrac{1}{8}\pi\rho_1 v_1^2 = P = \tfrac{1}{8}\pi\rho_2 v_2^2$

$$\therefore \rho_1 v_1^2 = \rho_2 v_2^2$$

$$\therefore v_1^2 : v_2^2 :: \rho_2 : \rho_1$$

ρ_1 and ρ_2 are densities referred to water. We can substitute in that expression s_1 and s_2, the specific gravities compared to air, because these are simply dependent on the pressure and temperature, and any cause which operates to increase the density of the gas will increase the density of air in the same ratio. The specific gravity compared to air remains the same, for the ratio $\frac{x\rho_1}{x\rho_2}$ is the same as $\frac{\rho_1}{\rho_2}$.

It should be noted that the law of effusion of gases holds true whether the gases stream into a vacuum or not. St. Venant and Wantzel found that the back-pressure—*i.e.*, the pressure of the atmosphere into which the gas streams—could be increased up to half the value of the pressure that forces the gas out, without alteration of speed.

Limits of Accuracy of Effusion Tests.

The accuracy of the determination by means of an effusion test depends very largely on the accuracy of the timing of the rate of efflux. For example, suppose the times of effusion for air and gas are 80 seconds and 60 seconds respectively. [These are normal figures for the specific gravity bell.]

$$\text{Specific gravity of gas} = \frac{60^2}{80^2} = 0{\cdot}5625.$$

If the times of effusion are 80 seconds and 59·5 seconds, the

$$\text{specific gravity of gas} = \left(\frac{59{\cdot}5}{80}\right)^2 = 0{\cdot}5532.$$

Hence an error of 1 in the second significant figure is occasioned by an error in timing of 0·5 second.

In order to secure a result reliable to the fourth significant figure, it is necessary to time with an accuracy of a fifth of a second for a total time of effusion of about 4 minutes.

Effect of Water Vapour.

Effusion tests always give the ratio of the weight of a volume of gas measured under prevailing conditions to the weight of an equal volume of air measured under the same conditions. In the Bunsen apparatus, both air and gas are dry; and the value obtained is the true specific gravity of the gas referred to dry air. In Schilling's test, the gas and air are measured over water; and under different conditions an error will be caused, due to the varying amount of water vapour taken up. The value obtained for the specific gravity will vary, although the composition of the dry gas remains constant, and therefore its specific gravity referred to dry air is unaltered.

For example, if the dry gas is of specific gravity 0·5, referred to dry air, then at 25° C. and 720 mm. pressure the specific gravity obtained with a Schilling apparatus will be 0·51.

Lux Balance.

In this well-known instrument, the specific gravity of the gas passing through is observed by the indication of a movable rider on the beam and of a pointer, which moves over a graduated scale.

Let the absolute weight *in vacuo* of the gas-globe be W

" " " of air filling the globe at N.T.P. be W_a

" " " of gas " " " " " " W_g

Weight of globe full of air at N.T.P. immersed in air $= W - W_a + W_a$

" " " " " " " $= W$

" " " gas " " " $= W - W_a + W_g$

Therefore the force displacing the balance, when full of gas, is equal to a weight $W_a - W_g$; and this force is balanced by an adjustment of the rider and by an alteration of the position of equilibrium, as indicated by a movement of the pointer. Now let the external conditions of temperature and pressure alter so that gas and air are x times as dense.

Weight of air displaced by globe is $x\,W_a$

" " gas in globe is $x\,W_g$

$\therefore$ Weight of globe full of gas is $W - x\,W_a + x\,W_g$

Force displacing balance is $x\,(W_a - W_g)$,

and the indication of the balance will be x times as great as before—*i.e.*, it will indicate density compared to a constant invariable standard.

Gravitometer.

The theory of the action of the gravitometer is somewhat involved, and, as a considerable degree of misconception exists, the action of the instrument will be considered in some detail.

A full description of the apparatus appeared in the "Journal" for Dec. 24, 1912, pp. 958-9; but for the sake of clarity of argument it is desirable to recapitulate it. A (fig. 1) is a light aluminium bell sealed in oil contained in the annular tank B. The bell is covered by a shell C, which is not in contact with it. The top of the shell carries a tube D. The bell is free to move up and down, and is carried by a vertical support connected to the end of the balance-beam G by a hanging chain. The other end of

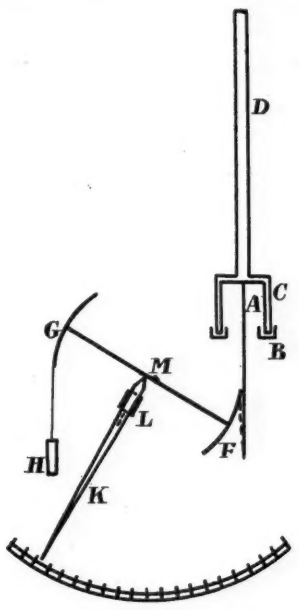


Fig. 1.

the beam carries a hanging weight H. The chains connected to both H and A pass over circular arcs. A pointer K and a gravity control weight L complete the essentials of the instrument. Suppose a stream of gas is passed slowly over the bell A and up the tube D. The pressure on the top of the bell A is diminished, and the pointer K swings to a new position of equilibrium. The scale over which the pointer moves is graduated to read or to record specific gravity directly.

The following theory appears at first sight to afford a complete explanation of the action of the instrument; as a matter of fact, it is the explanation which is accepted by the majority: Let the diameter of the bell be d and the height of the vertical tube be h. The total pressure upon the upper surface of the bell A is that due to the weight of a column of air of diameter d and height of the atmosphere, less the difference between the weight of a column of air of diameter d and height h and the weight of a column of gas of equal size. The pressure on the underside of A is simply that due to the weight of a column of air of diameter d and of height equal to that of the atmosphere. Hence by passing a light gas over the bell, the weight acting on the top is relieved by the difference between the weight of a column of air of diameter d and height h and the weight of a column of gas of equal size. This relief of weight alters the position of equilibrium and causes the pointer to move across the scale. In the case of a gas heavier than air, the action is exactly the same; but the motion is in the opposite direction.

According to this explanation, the indications of the gravitometer should be affected by variations in temperature and baro-

meter. For example, suppose the air column weighs x grammes, then the gas column (sp. gr. 0·5) would weigh $\frac{x}{2}$ grammes, and the difference in weight causing the pointer to move is—

$$x - \frac{x}{2} = \frac{x}{2} \text{ grammes.}$$

Suppose, now, the external conditions vary so that both air and gas become q times as dense. The weight of the air column is $q\,x$ grammes, the weight of the gas column is $\frac{q\,x}{2}$ grammes, and the difference is now $\frac{q\,x}{2}$

This is, the difference is q times as great as before. Since the scale of the gravitometer is uniformly divided, the specific gravity indicated would be q times as great as formerly.

As the instrument when in use remains quite unaffected by any change in the external conditions, it is obvious that a clear account of the actual principles of the instrument should be of use in clearing away this misconception. Consider the two bells A and B (fig. 2) sealed in oil in annular tanks C and D. Each bell is covered over by a shell, which is prolonged by a tube as shown in the diagram. The two bells are carried by the beam F^1 F of a balance which turns about a fulcrum or knife edge G.

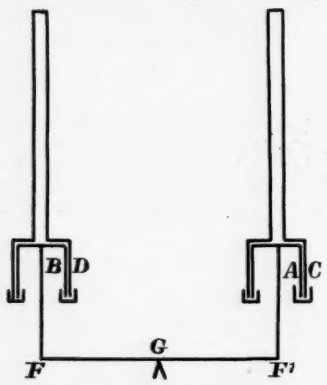


Fig. 2.

Now suppose that a gas of specific gravity s is passed over the bell A and up the tube; while the shell and tube above B are still filled with air. The weight pressing upon the top of the bell A is the weight of gas, specific gravity s of height equal to that of the tube and diameter equal to that of the bell. Similarly the weight on the top of the bell B is the weight of a column of air of similar size and equal to (say) W. As the atmosphere has free access to the underside of A and B, and also to the top of the two tubes, all that need be considered are the weights of the columns of gas and air within the shell and tube.

Now suppose that the pointer is in equilibrium in a certain position—say, s. This means that the product of the weight of the column of gas and the distance of its centre of gravity from the point of support G is equal to the product of the weight of the column of air and the distance of its centre of gravity from the point of support G. It is quite obvious therefore that if (say) the weight of the column of gas in A and the weight of the column of air in B are both increased x times, the ratio of the two—*i.e.*, the specific gravity of the gas still remains s, and the position of equilibrium of the balance is unaffected, because if we multiply the moment of the weight acting upon each end of the beam by x, the products are still equal.

Let us now consider the column of air above the bell B. It is quite obvious that the equilibrium will be unaffected if we remove the tube and shell. It is also obvious that there is no particular reason for making B in the form of a bell, as it can be now replaced by a cylindrical weight equal to that of the material used. This arrangement, together with a gravity control weight, constitutes the gravitometer.

The function of the gravity control weight may be briefly described as follows: The ratio of the weight of the column of the gas to the column of air is s. And in order that the moment of the weight of the column of gas at M (fig. 1) may be equal to the moment of the weight of the column of air, it is necessary that the lengths of the arms GM and FM be in the ratio to one another of $\frac{1}{s}$.

For example, if the gas is of specific gravity 0·5, FM must be equal to half GM. The function of the gravity control weight is to vary the length of one of the two arms of the gravitometer beam (which, for the purposes of argument, may be compared to a steelyard) in proportion to specific gravity. The way in which this is effected is as follows: The bell of the gravitometer is carried by a chain which passes over the arc of a circle of radius equal to the arm FM. This means that the centre of gravity of the bell, and therefore of the superincumbent gas column, always remains at a fixed distance from the point of support M. Consider now the arrangement on the other side of the beam. The hanging weight is also carried over a circular arc; and its centre of gravity is therefore at a fixed distance from M. But the gravity control weight, which includes a weight L and a pointer K, occupies a different position in relation to the centre support M according to the position taken up by the balance beam. In other words, the centre of gravity of the system of weights, including the hanging weight and the gravity control weights L and K, will be variable, and will be different for every different position of the beam. The compensating column of air may be regarded as exerting its influence through the centre of gravity of the system. In other words, the gravitometer can be regarded as a steelyard in which the movable weight is the column of air. This movable weight is applied through the centre of gravity of the system consisting of the gravity control weights and hanging weight. The position of this varies according to the indication on the scale; the whole arrangement being such that the ratio of the two arms of the "steelyard" is in inverse proportion to the specific gravity of the gas. Once the conception of the gravitometer as a steelyard is established, it follows that influences of atmospheric pressure and temperature cannot affect the indication of the instrument, as they affect the gas and air columns in equal ratio.

In starting the instrument from zero for calibration—its position being that of equilibrium, which is effected by the influence of the gravity control weight and the pointer—if the beam on the bell side is loaded with a weight equal to one-half of the estimated weight of the column of air, the balance will assume a definite position which neutralizes the effect of this difference of weight, and the ratio of the arms of the gravitometer has been altered from the unknown ratio to a fixed proportion of 1 to 2. Now it is obvious that if any changes in barometric condition occur when the bell is filled with a gas (which has taken the place of the weight which has been placed on the beam), the weight of the gas must necessarily be half the weight of a corresponding column of air, and barometric changes must preserve this ratio of 1 to 2. If, now, a gas is introduced of (say) 0·25 specific gravity, the beam assumes a new position, and the length of its two arms is automatically rearranged in the ratio of 4 to 1. Under these conditions, all barometric changes will affect the gas and air in exactly the same ratio. In each case we come back to the condition of a steelyard, in which the leverage of the two arms is in proportion to the weights imposed upon them.

Use of the Gravitometer as a Control for Recording Calorimeters.

The specific gravity control in a recording calorimeter is required to correct for changes in the density of the gas, so that a constant rate of flow is maintained through a fixed orifice. Changes in density are due to:

1—Variation in actual composition.
2—Influence of external conditions—*i.e.*, temperature and pressure.

Let us suppose that the balanced bell of the gravitometer is made the tail-weight of a governor, and that the gas is admitted to the underside of the bell so that the latter sinks with decrease of specific gravity. This movement of the bell is arranged to open and close a valve which controls the supply of gas to the burner If the bell sinks, owing to the decreased specific gravity, the valve closes partially to compensate for this, and the rate is automatically maintained constant for variations in composition.

It is quite obvious that this control only corrects for changes due to variation in actual composition, and does not correct for those due to external conditions of temperature and pressure—seeing that it merely controls according to the specific gravity of the gas referred to the external atmosphere, which latter is, of course, equally affected by changes in the external conditions. In the recording calorimeter, known as the calorgraph, the correction for variation in external conditions is effected, not by the specific gravity control (which has been proved not to correct for this), but is brought about by the variation in the density of the heated air column. [Air is the substance to which heat is imparted in this instrument.] If the gas becomes x times as dense owing to changes in external condition, the air also becomes x times as dense, and requires x times as much heat to bring it to the same temperature as before.

Now temperature of the air column is proportional to

$$\frac{\text{heat evolved}}{\text{weight of air heated}}$$

In the first case, this is $\frac{C}{W}$. When the gas and air are x times as dense, this becomes $\frac{x\,C}{x\,W}$ which $= \frac{C}{W}$—*i.e.*, the indication of the calorgraph is unaffected.

Munich Gas Exhibition.

We have been requested by the promoters of this exhibition to extend to the English gas industry in general a cordial invitation to visit Munich in July or August of this year. The promoters announce that "a visit will be well repaid, for it can already be said for certain that this will be the largest exhibition of the gas industry that has ever been held anywhere; and the technical and scientific qualities of the German gas industry, which is working together to this end in complete harmony, is sufficient guarantee that the quality of the exhibits will in no wise fall short of their quality." As already announced, King Ludwig III. of Bavaria, who is an enthusiastic patron of all branches of engineering, will himself perform the opening ceremony.

THE PIPE FOUNDRIES AND MINES OF NORTH-WEST FRANCE.

By An Occasional Contributor.

The writer recently had an opportunity of visiting the iron districts of France—travelling by road and rail through country which was not many years ago a land with only agricultural possibilities. In this portion of French Alsace, the iron ore was discovered about 1883. These mineral deposits are now known to cover a very considerable area; and one sees on all sides the pit-head gear, blast-furnaces, and chimneys where very few years ago there was scarcely a building to be seen.

The district extends roughly from Nancy on the south nearly to Dinant (Belgium) on the north, and from Metz (Lorraine) on the east to Charleville on the west—roughly 100 by 70 miles. The writer visited two foundries—Pont-à-Mousson and Villerupt—which are owned by different Companies, and the iron mines at Auboué, which are in the hands of the first-named Company, who have a foundry at that place also. The second Company have another foundry at Aubrives, almost in Belgium; while the first have a third foundry at Foug, some miles west of Nancy. The two concerns are the largest in the country. The district includes the famous steel-works at Longwy and Pompey—the former having an area of 6600 acres. Both works have their own iron mines and blast-furnaces.

Dealing with the foundry and ore production, the following table gives the size of the undertakings in question.

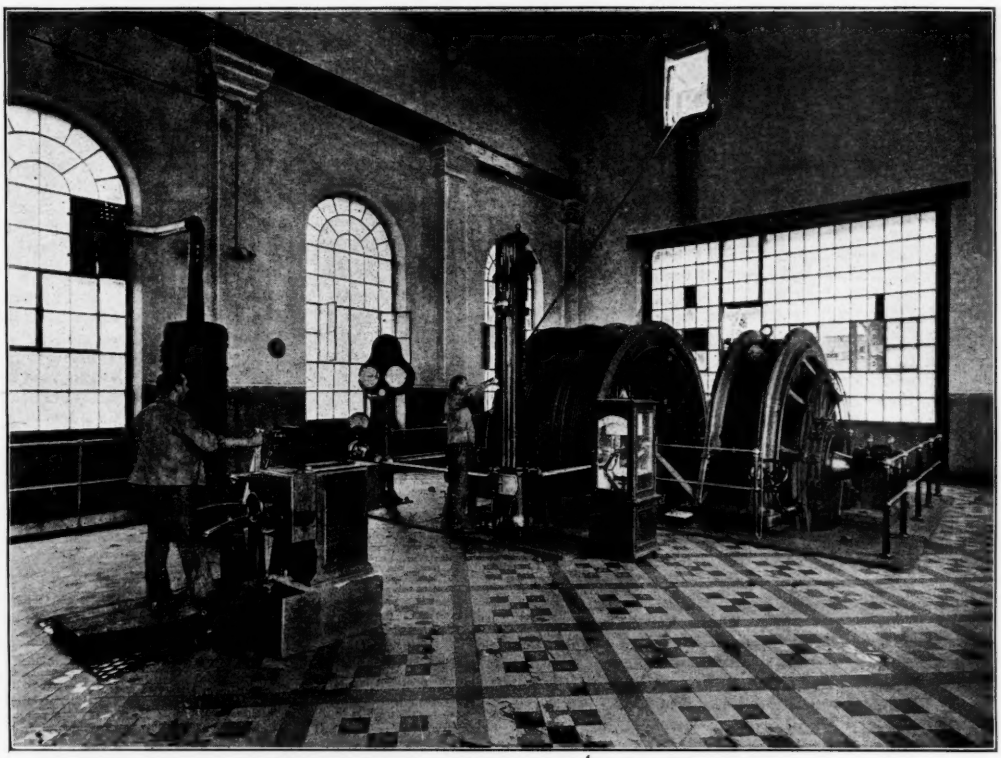
—	Pont-à-Mousson Company.		Aubrives and Villerupt Company.	
Blast-furnaces	Pont-à-Mousson.	8	Villerupt	2
	Auboué	3	Aubrives	—
		11		2
Cupolas	Pont-à-Mousson.	20	Villerupt	8
	Foug	10	Aubrives	5
		30		13
Yearly output, iron ore, tons.	3,000,000		200,000	
,, ,, pig iron ,, .	330,000		85,000	
,, ,, castings ,, .	200,000		75,000	
,, ,, pipes only. .	150,000		70,000	
,, ,, ,, exported	70,000		40,000	
,, . ,, bricks . . .	30,000,000		—	

The Iron-Ore Mines at Auboué.

The mines at Auboué generally are similar to others, but are deeper—in fact, in parts the ore is found very near the surface. In France, when operations for trial borings are contemplated, notice has to be given to the State, and permission obtained. When the mineral is found, notice has to be again given, and permission sought to work the deposits. The State then draws a percentage tax on the production of the mine. The mere purchase or lease of land does not carry any right whatever to work the minerals.

These particular mines have two extraction shafts, 500 feet deep, and one air shaft. The ventilation is a simple matter. No special precautions are taken, and no special apparatus is necessary to effect it; the small amount of water found being easily dealt with. The size of the passages is from about 20 to 25 feet in breadth and 10 feet in height. The total length of the passages actually used is about 34 miles, of which 16 miles is worked by electric traction, 16 miles by hand, and 2 miles by cable. In addition, there are many miles of passages which have been worked, or are out of use for other reasons.

The drilling is effected by compressed air; drills up to 8 or 10 feet long being used on occasions. After the explosion (for which ordinary gunpowder is used), extraction is easily made by a pick. The waggons carrying the ore to the foot of the shaft have a capacity of 1½ tons; and the usual train length is thirty waggons. Arriving at the foot of the shaft, two waggons (3-ton) are hauled up at a time; the empty waggons being returned in the adjoining section of the same shaft. The empty waggons are discharged in the opposite direction from the arriving full ones. The operation is completed in 1½ minutes or less—*i.e.*, the empty trucks arrive at the base 1½ minutes after full ones have left in the same section. On arrival at the pit head, the trucks are collected.



THE POWER HOUSE AT THE AUBOUÉ IRON ORE MINES.

Five sets of rails lead to the temporary storage hopper, the capacity of which is 3600 tons. These five lines of rail will feed the hopper at any portion; and the automatic tipping gear can travel to collect as many as six trucks from any of these five lines.

An illustration is given of the power-house, showing the position indicator and speed indicator and chart. The motors have a capacity of 1050 amperes at 230 volts, equal to 350 H.P. The indicator gives the position of the rising and falling waggons by means of a stop on a square-threaded screw; and there is automatic gear for the governing of the speed when it reaches its maximum. The speed-indicating chart is the usual revolving drum type. Although the motor has such a large capacity, the counterbalancing is so arranged that very little power is necessary. When moving at the maximum speed, only 5 or 6 amperes are required.

The area occupied by these mines and works is nearly 750 acres; and over 2000 men are employed. Many of the workmen are Italians, as there are not sufficient Frenchmen of the class to be found. Much of the ore is exported to Scotland and Middlesbrough, and other French foundries are supplied in addition to the Company's works at Pont-à-Mousson and Foug.

The blast-furnaces at Auboué are very large ones, each capable of producing 180 tons a day, or 540 tons in all, and even a little more when under pressure.

Pont-à-Mousson Foundry and Furnaces.

These furnaces, eight in number, have a present capacity of

530 tons a day, soon to be increased to 630 tons. As this foundry is very similar to English foundries, a description is unnecessary. The writer was struck with the large number of small diameter pipes being cast (1½ in. to 2 in.). There is evidently a huge business still carried on in cast pipes of diameters which an English gas engineer would never consider. Pipes of 2 inches diameter have been successfully cast in 3 metre (9 ft. 10 in.) lengths. This foundry was established in the year 1856, and has a roofed-in area of nearly 12 acres. Besides gas and water pipes, they cast drain pipes, manhole covers, railway chairs, &c.

The coating process is interesting to one acquainted only with English methods. After leaving the trimming shop, the pipes are placed on a conveyor, consisting of a double moving chain. There is a circular hook on each portion of the chain in which the pipe is carried—one near each end of the pipe. The pipes are then heated in a chamber kept at a temperature of about 150° C. This chamber is immediately adjoining a tank containing a mixture similar to Dr. Angus Smith's solution, kept at nearly boiling point. Immediately on emerging from the heating chamber, the pipe is carried by the conveyor down into the rectangular tank, slowly through it, and up on the opposite side. The breadth of the tank is about 12 feet; the length being able to take 4-metre pipes (13 ft. 2 in.) with ease. The conveyor then deposits the pipe on to the usual traversing rails, where it dries. The pipes are then ready for putting into truck or barge.

The advantages of the system appear to be quickness and economy, and the coating of each pipe without it being in contact with another. The disadvantage is the liability of accumulated coating inside owing to the pipe being kept in the horizontal position when dripping and drying. An examination of the pipes in stock, however, showed that this disadvantage is not of serious proportions. The economy is proved by the fact that no extra charge is made for coating; and owing to transport arrangement, the foundry would rather coat the pipes than leave them plain. For hand coating, outside only, leaving the 6 inches at the spigot end, 2s. a ton is charged.

In both works visited the pipes are cast vertically, with sockets downwards; the number of pits at Pont-à-Mousson being nearly seventy. On the occasion of the writer's visit, 40-inch pipes were being cast. The Pont-à-Mousson Company employ 6500 men. The total area of roofed-in works is 44 acres, with a total area of works and mines of 2000 acres. In addition to the articles enumerated, they manufacture bolts and rivets, and 50,000 tons of cement.

The Villerupt Foundries.

This foundry is about the most up-to-date in the country, in regard to the method of casting, which will be shortly described. The advantages are quickness and cheapness of production; the same area of ground being capable of greatly increased capacity. Regarding the superiority or otherwise in the pipe produced compared with that made by the old method, the writer does not propose to enter.

The method may be described as the "turning table system." This may not be the correct technical description; but it aptly describes it. There is no pit. The foundry is a double-floored one; the table containing the frames being elevated. The Villerupt new foundry contains five such tables, and will shortly be extended by two more for larger diameters. The first of these circular tables carries at its circumference forty frames or models, capable of producing 160 pipes of 3 inches, 4 inches, or 5 inches in diameter—that is, each model produces four pipes a day. The four other tables make various sizes; the largest one containing 29 models capable of turning out pipes up to 16 inches diameter. Of the latter diameter, 36 pipes per day can be made. The total capacity of the five tables is 100 tons a day; while the old foundry at the same works can turn out from 100 to 120 tons a day.

The table revolves on a large central spindle, carrying the models round to the points on the circle at which the various processes are effected. Thus there is no waste of time. The sketch illustrates the principle. The moulding tool, shaped somewhat similar to a large bradawl at the end, with a smooth cylindrical shank the exact size of the outer diameter of the pipe, is introduced at A, the socket being separately shaped at the base from below; the top of the table, where the remaining work is carried out, being on the upper floor. Mounted above the table is a crane used for all purposes—such as taking the core in and out, handling the pipe when finished, and handling the molten metal if necessary.

The wet clay is introduced into the model, and the shape formed by the revolution of the moulding tool. Special arrangements are made to keep the tool vertical; the finished surface being compressed in the process. From A to B the mould is drying. At B the molten metal comes direct from the cupola; the skip being carried on a monorail from the end of the building. The same monorail serves all five tables. At B the core is inserted, and the metal poured in. The core is kept vertical by the bottom end of its spindle being made to fit into a socket fixed to the bottom of the model. The top is then shouldered out to the full size of the top of the original mould, and thus the metal is quite concentric. [See sketch.]

The core is made by an under layer of straw with solid earth over. The clay is applied in the usual way in two coats; the under one shrinking on drying and leaving a key for the application of the final coat. The founders sigh in vain for a permanent core. At C the core is removed; the time occupied in transit from B to C being 15 to 20 minutes. The total time from the

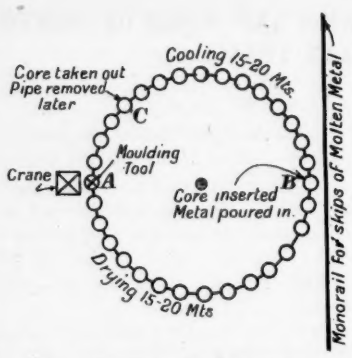
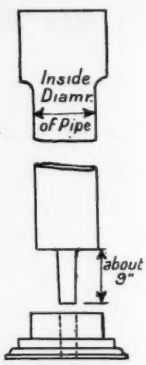


Diagram of Turning Table.



Ends of Core.

clay being first put in to the point at which the pipe is cool enough to be taken out is from 2 to 2½ hours. The pipe is then lowered by the crane to the bottom floor, and it is ready for trimming.

The coating apparatus is very good, but not so quick as that previously described. After passing through the heating chamber (nearly 200° C.), the pipes are picked up by a chain with treble claws at each end, to hold three pipes at an angle of 45°. These are dipped in the hot solution three times, and are then placed to drip on an inclined bed, where they are moved along in rotation. A small travelling crane does all the handling from the heating chamber until the pipes are ready for sending out.

The Aubrives and Villerupt Company have nearly 2000 employees, a total area of roofed-in works of 13 acres, and a total area of works and mines of 2300 acres. The furnaces at Villerupt are over 70 feet high.

The Company have built between 200 and 300 houses for their workmen, of good design and bright appearance. Attached to offices there is an up-to-date operating room, fitted with the latest appliances and always kept at a warm temperature. There is also a dispensary, and one or two fully-equipped bedrooms ready for cases which would not allow of the injured being removed. A medical man attached to the staff is always available.

Notes Concerning both Foundries.

Pipes are cast as small as 40 m.m. (1½ in.) internal diameter and 2½ metres (8 ft. 3 in.) long. Pipes of 2 inches in diameter can be had in 3 metre (9 ft. 10 in.) lengths. The standard length above 6 inches is 4 metres (13 ft. 2 in.), and 4-inch, 5-inch, or 6-inch pipes can also be had in these lengths. The maximum diameter is 2 metres (6 ft. 7 in.); and pipes have been cast up to 5 metres (16 ft. 5 in.) in length, but not as a general rule.

There are testing arrangements of the usual type for all sizes above mentioned. The following are the standard tests:

1½ in. to 7 in.	diameter	25	atmospheres,	or 830	feet	head of water.
8 in. to 12 in.	,,	20	,,	660	,,	,, ,,
Above 12 in.	,,	15	,,	500	,,	,, ,,

Two types of socket are usually made for ordinary lead joints—viz., (*a*) City of Paris, (*b*) "English" type. The latter conforms generally to the shape to which we are accustomed, and, as a rule, the English buyer will get this shape delivered. The City of Paris type is curved on the outside, the contour continually curving, and is curved on the inside at the bottom, where our pattern has a square shoulder.

Two weights are in general use. The City of Paris and light "English" types run from 8 to 12½ per cent. lighter than the English founders' standards; while the intermediate "English" type is almost equal to our standard. The light patterns are sold in much greater quantities, as one can lay correspondingly further with the same weight without any great sacrifice in strength. In both weights the moulding tool—*i.e.*, the outside diameter—is constant; the difference in thickness being effected by difference in the size of the core. Thus in light pipes, there is an increase of area due to several millimetres extra diameter, which needless to say is never objected to by the purchaser.

Finally, the writer was much impressed by the general excellence and high state of efficiency in both foundries visited. The castings inspected were of good quality; and having had experience of the pipes on the district, the writer can testify to their soundness. If suited as to price, the buyer need not be afraid that he is getting anything but a well-made pipe manufactured from good materials. The increasing trade with this country of the two firms in question is the best testimony to this. Whether they are as good as or better than the home article does not come within the scope of this contribution.

A "Metallic Filament Mantle" Reported.—The London correspondent of the "Edinburgh Evening News" writes a paragraph regarding "Gas *v.* Electricity," which is certainly very interesting reading. The statement is as follows: "The fight between gas and electricity as the better means of street lighting is getting further stimulus from experiments, claimed up to their present stage to be overwhelmingly successful, in the further development of illumination by filament gas mantles. One of the big gas companies of the Metropolis has a metal filament mantle which it has brought to the stage of no less than 10,000-candle power with high-pressure gas. It requires no glass protection. The present acme for street lighting is from 2000 to 3000 candle power.

THE CARE AND MAINTENANCE OF THE "FIDDES-ALDRIDGE" SIMULTANEOUS RETORT CHARGING-DISCHARGING MACHINE.

By H. C. WIDLAKE, M.J.Inst.E., of the Plymouth and Stonehouse Gaslight and Coke Company.

THE writer feels that no apology, and very little explanation, is needed in introducing this article, as the growing popularity of these machines has, to his certain knowledge, created a demand for reliable data concerning their operation and maintenance. The introduction of the simultaneous type of machine has brought into being an apparatus which combines the characteristics of both the charging and discharging machines, for which, in a large number of works in England, on the Continent, and, latterly, in the United States of America, it is being substituted.

It often happens that when a new type of machine is introduced into a works it is so unconsciously abused and mishandled during the first year of its operation, owing to lack of knowledge of its characteristics, as to shorten its useful life by many years. There are certain points to which attention should be given before placing the order for the machine, and to which the importance of giving careful consideration cannot be over-estimated in view of the manifold advantages which will accrue in the way of freedom from trouble which is often due less to the machine itself than to the conditions under which it is set to work. In this respect it may be observed that alterations which could easily be effected before delivery are often quite out of the question when once the machine has been erected and is at work.

THE TRACK.

In many retort-houses into which these machines are introduced there already exists, on the charging side, a set of rails on which some previous type of charging-machine has run; and a very common mistake is to place the order for a "F.A." machine without giving due consideration as to whether the rails can be relied upon to operate satisfactorily under a machine weighing, perhaps, nearly twice as much as the one for which they were primarily installed. This consideration becomes of even greater importance in cases in which the new machine carries a hopper of sufficient capacity to charge several retorts.

The track on which a retort charging and discharging machine has to run is subjected to a strain which, so far as the writer is aware, is peculiar to this class of work—namely, the strain brought about by the heavy "back-thrust" which occurs during the pushing out of the coke. With coal of average quality carbonized in a well-scurfed retort, the mean power exerted during this pushing stroke is rarely less than 15 H.P., and at the moment of the nose of the chain meeting the caked coke may be as much as 25 H.P. The latter figure, however, is only reached momentarily, and need not prove alarming to any prospective users of these machines, as it must be remembered that the series type motors with which they are fitted are of the same kind as those used on the street cars, cranes, foundry chargers, &c., and possess an enormous capacity for dealing with momentary overloads, which capacity it is usual in practice to limit by means of an electrical device with which the writer proposes to deal later.

The thrust due to this pushing stroke is taken entirely by the rails; and too much emphasis cannot be laid upon the importance of providing a well-designed track of ample rail section. The wheel base of an ordinary "F.A." machine takes the form of a square; and it will readily be seen that a bad rail joint or any irregularity in the track must inevitably throw an enormous strain upon the whole machine. The author does not mean to imply that these machines will not give good service on a bad track. They will, and do in many places; but a machine working under these conditions must become a candidate for the scrap heap many years before one which has not such unfair strains to contend with.

FEEDER WIRES.

These usually take the form of a pair of hard drawn copper wires of the same type as those used on the overhead lines from which street-cars take their supply, and are run on insulators either over or at the back of the machine, into which the power is conveyed by means of collectors. In determining which of the two positions should be used for the wires, due consideration should be given, as far as possible, to any structural alterations which may be contemplated in the retort-house with which these wires, injudiciously installed, would interfere. So far as is possible they should be placed where they cannot be handled either from the ground or from any conveyor or elevator superstructure; and a suitable guard should be provided over them.

A retort-house delay, fresh in the writer's mind, was caused by the breaking of a driving chain on a coal-elevator, which, falling to the ground, broke one of the overhead wires in its passage. The serious nature of, and the loss occasioned by, such delays cannot be exaggerated. In the installation of these machines in the No. 1 retort-house of the Plymouth and Stonehouse Gaslight and Coke Company (with which the writer is associated), each charger is fitted with a double pole plug box bolted to the back of the frame, into which a wandering lead can be inserted, and its other end connected to one of four equidistant plug-boxes fixed on the retort-house wall and fed from a circuit entirely independent of that from which the overhead wires derive their supply. This arrangement has proved to be of the greatest value, and ensures that, whatever may happen to the trolley wires or to the collectors themselves, the operation of the machines can still be carried on with equal efficiency from these wall-boxes.

On a straight run, it is neither necessary nor advisable to use suspension ears for this class of line; and the wire should be run freely from end to end of the retort-house, resting on reel insulators pitched about 20 to 30 feet apart. In the event of replacement, long tension buckles at each end of the retort-house, fixed on the wall side of two globe strain insulators, will greatly facilitate this operation, and should be installed in preference to the adjustable strain insulators so often met with in these installations. A pair of "come-along" clamps and a small block and tackle will bring the wire up to these buckles, with which the final tension can be rapidly applied. Fig. 1 shows the type of collector used on the plant under the author's care. It will be seen that they are equally adapted for either roof or back collecting.

The collector wheel lifts the wire clear of the grove in the reel insulator in which it lies, and into which it drops after the passage of the machine; and it is found in practice that the weight of the wire on the collector wheel ensures a perfectly satisfactory contact—the collection of current on the heaviest loads being accomplished quite sparklessly. Small automatic lubricators, filled with vaseline, ensure smooth running of the wheel on its spindle; six months being the average life of a collector wheel. The height of the points from the ground where the trolley wires are anchored at the ends of the retort-house should be slightly less than the

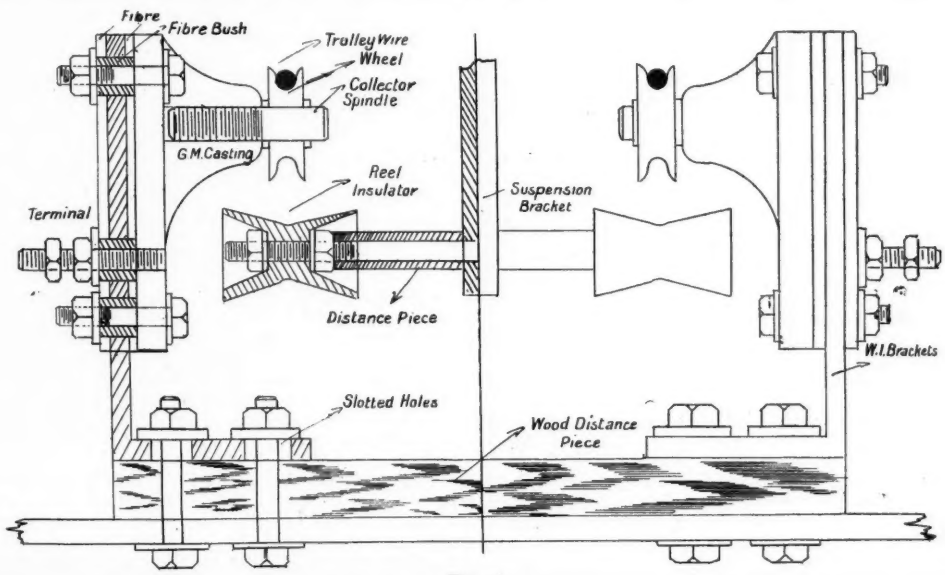


Fig. 1.

distance between the rail and the centre of the collector spindle, so as to ensure that, when running a machine up to the extreme end of the track, the collector maintains proper contact with the wire at these points.

Switch-Gear.

More depends upon the judicious choice of control gear than would at first appear; and it may safely be said that freedom from mechanical, as well as from electrical, breakdown, may be largely attained by proper attention to this point. Allusion has been made to the large overload capacity which a series motor possesses—a characteristic which makes it peculiarly suitable for heavy duty, but at the same time one which becomes a danger to the whole machine unless properly controlled. At this point it may not be out of place to deal with the relationship between the load, current, and speed of a series motor.

The current passing through the windings of a series motor varies inversely with the back electromotive force of that motor which is proportional to the speed; and in this respect the dual characteristics of a motor and a dynamo become apparent. A direct-current motor operating under any load also acts as a dynamo, inasmuch as the rotation of the armature in a magnetic field induces in its windings an electromotive force or pressure in the opposite direction to the incoming current, which it opposes, for which reason it is known as the back, or opposing, electromotive force.

A moment's consideration will show that the higher the value of this counter pressure the less current will be taken by the motor; and as this back-pressure varies with the speed, it follows that, roughly speaking, the current taken by the motor is inversely proportional to its speed. Proceeding, now, to apply this reasoning, we see that on the occurrence of an overload, which, of course, causes the speed of the motor to drop, an increased current immediately flows through its windings, creating, in a motor of the series type, a heavier magnetic field.

Among other factors, the torque of a motor, and hence its horse power, is proportional to the field strength; and the heavy torque or driving effect which now exists can only be advantageous when properly limited, as, if allowed to attain dangerous proportions, it must result in damage—not, it may appear strange, so much to the motor, as to the gearing of the machine. Under such conditions, it is simply a case of "something has to go;" and, in justice to the persuasive powers of a well-designed series motor with plenty of power behind it, it is only fair to add that "something" generally does go—unless, as has been pointed out, proper precautions are taken in the intelligent selection of the switch-gear employed.

A fuse-box alone cannot be regarded as an efficient safeguard; and in making this assertion the writer is entirely guided by practical, and in some ways sad, experience. A fuse may be regarded as a circuit breaker with a thermal time limit, and cannot open a circuit instantaneously. The time which a fuse takes to reach the temperature at which it melts or "blows" is dependent upon its type, the distance between its terminals, the nature of its covering, and its normal working temperature—factors which all combine to produce a time limit in which, in the case under discussion, almost any damage may be done. A fuse effectually limits the duration of an overload; but it cannot prevent the heavy torque which, consequent upon an overload, a series motor must exert, and which can, and does, break up something before the fuse acts.

The writer's experience shows that the fuse-box should be supplemented by the installation (on one pole) of an automatic magnetic circuit breaker; and it may be said that for this purpose the tramway type of breaker answers admirably, being practically instaneous in its action. In the selection of a circuit breaker, the question naturally arises whether this should be of the fast or loose handle type; and this issue must depend upon the reliance to be placed upon the commonsense of the men who operate the machine, upon the training of whom it is the writer's intention to devote attention later in this article.

The loose-handle circuit breaker has a comparatively greater number of parts than the fast-handle type, and is consequently more complicated; its one advantage being that it cannot be held in on a short circuit or overload.

The tendency to hold or tie a breaker in when it becomes "lively" is about as sensible as the practice of hanging bricks on the lever of a safety valve, or even of sitting on such a valve to prevent its blowing. Of course, a loose-handle circuit breaker effectively guards against this, but the writer much prefers using a second circuit breaker (set slightly higher than the one on the machine) on the "F.A." circuit on the distribution switchboard. Should the breaker on the charger be subjected to the form of abuse outlined above, the second switch opens on the occurrence of an overload, but under ordinary working conditions remains closed owing to its slightly higher setting. In practice, it will be found that both breakers only drop in the event of a heavy short circuit.

These precautions may be regarded as rather elaborate; but the author begs to assure any who may be inclined to this conclusion that attention to these simple, and comparatively inexpensive, points will be more than repaid. It must be remembered that the cost of a single replacement of a broken casting or item of gearing will more than pay for two 100 ampere circuit breakers, to say nothing of the loss occasioned by delay in a one-machine installation.

Another valuable argument in favour of the circuit breaker is the time it saves, as it must be borne in mind that, even assuming a fuse had no time limit and could be relied upon to open a circuit synchronously with the occurrence of an overload, a circuit breaker can be replaced in one second, whereas a fuse replacement causes at least a minute's delay, during which time the retort in which the chain lies, and in all probability the next one to be charged, is open. Any delay which leaves the chain in a heated retort a moment longer than is absolutely necessary is to be avoided, and for this reason alone a safety device having a quick replacement characteristic should be used.

Over-run Switch.

There are many switches of this class on the market, one of which is a standard fitting on the "F. A." machine. A mistake which is to be avoided is to regard it as a superfluity serving an ornamental rather than a useful purpose. It is fitted with a definite object; and the user who dispenses with it can only be regarded as unwise, not to use a stronger expression. So long as the machine is properly operated, this switch is never required; but in the event of a sudden illness or momentary lapse on the part of the operator, its action is quite positive and prevents any damage to the whole of the charging gear. In its office, it may be likened to the "dead-man's handle" in use on electric underground railways. It may be argued that, in the event of an overrun, the circuit breaker would act the moment anything hung up. But it must be remembered that a large amount of energy is stored up in the chain and other moving parts, which has to be expended before these parts come to a standstill.

The Training of Operators.

The *bête noire* of the engineer in charge of an electric retort charging plant is the man who rushes his controller—an individual who usually combines with this characteristic the playful habit of holding or tying-in his circuit breaker. It is certainly a fact, and a rather humorous one, that a man who is addicted to these practices when he is comparatively free from observation may attain the reputation of being a good operator, and be regarded as a more skilful workman than the man who takes a little longer over his retorts by treating his equipment with consideration and allowing the circuit-breaker to exercise its legitimate function. If a driver is known to persist in these pernicious practices, it is far better to relieve him of his duties than to run the risk of the damage which must inevitably ensue.

Close observation by the carbonizing foreman can do much to prevent any abuse of this sort, provided that he himself understands the dangers of these practices (which is not always the case). But an operator cannot be kept continually under observation; and the machine should only be entrusted to men who are known to possess a sufficient degree of training and intelligence to ensure its proper manipulation, as improper handling not only injures the machine, but may do considerable damage to the retort settings—an even more serious matter.

The careful operator is the natural outcome of proper training; and if it is at all possible, the writer strongly urges that the prospective user of these machines should have his raw material trained at some local tramway depot, where a few hours spent practising with a dead, and, later, a live controller, supplemented, of course, by instruction from a competent motorman, will be quite sufficient to ensure that the new machine will have proper treatment.

In a wide experience of street-car undertakings, the writer has rarely come across motor men who misuse their controllers; and he is convinced that this is due to the fundamental principles which are, metaphorically speaking, hammered into them from the first moment they put their hands on a controller. "Rushing" a controller is regarded by most English tramway officials as a serious offence, and is dealt with accordingly; but it is only fair to say that the great majority of street-car drivers would as soon think of throwing their power handle right over to the top notch as a locomotive driver would think of pushing his regulator wide open when standing still.

In retort-house practice, electrical principles must, to some extent, become subservient to local conditions; and there are, admittedly, occasions when a controller has to be "picked up" rapidly. A properly trained driver, however, can be relied upon to use his discretion in such cases, and will get through an exceptionally bad retort without mishap; whereas an untrained man would fruitlessly expend a large amount of time, fuses, current, and bad language over the same retort, and finally pass it over with a burnt-out circuit breaker and a damaged chain nose piece.

An experienced operator judges the load on the motor by the speed of the chain wheel; and when a tendency to slow-up is observed, the controller should be moved back one or two notches, and the "push" continued at a lower rate of speed. It may here be observed that tight retorts should never be pushed on the top notch. If it is found necessary to start the coke by means of a blow, the nose should never be backed more than about two or three inches, as any further withdrawal must result in some loss of coal.

If some particular retort is known to be tight, it should be pushed and charged separately, and, needless to add, should be scurfed at the first opportunity. If it is found that the mass of coke in a retort is so caked that it cannot be started on the third or fourth notch, nothing can be gained by putting the controller further up, as, the resistance of the standing motor

being negligible, this can only result in the creation of a short-circuit on the supply feeders.

Co-operation between the electrician in charge of the equipments and the carbonizing foreman can do much to ensure smooth working, as, if the former is advised from time to time as to the varying nature of the coke, he can set the charger circuit breaker accordingly. With some cargoes it will be found that the power required on the pushing stroke is greater than with others; and while such are being worked through, much vexatious delay may be avoided by screwing the circuit-breaker up a little.

Although it is a luxury, a recording ammeter on the "F. A." machine circuit will be found to give a permanent graphic record of the handling of the machines, the state of the retorts, and the character of their contents, which, properly dated and filed away, may prove of the greatest value.

(To be continued.)

WATER SUPPLY AND ENGINEERING QUESTIONS.

At the Annual Meeting of the Society of Engineers, Mr. H. C. H. SHENTON delivered his Presidential Address, in the course of which he made the following remarks on the subject of water supply and engineering.

WATER SUPPLY.

At the present time there are certain definite lines of policy that are observed in connection with water supply, and certain principles have also been accepted which will have a far-reaching effect upon engineering work in the future. These are of various kinds, and are the outcome of general experience, research work, the work of the Royal Commissions, and other causes. It has been established within the last few years, and has been definitely confirmed by the eighth report of the Royal Commission on Sewage Disposal, that water authorities must be responsible for purifying waters drawn from a river, while the local authority discharging sewage into a river need only purify their sewage to such a degree as to prevent actual nuisance. It is also now generally acknowledged that there is need for the collection throughout the country of data as to sources of supply. A systematic hydrographical survey is required. We need to have fuller particulars with regard to rainfall, the run-off of the land, and the yield of streams and rivers. The formation of a Central Authority and of Water Boards is required, so that the national supply shall be considered as a whole; and though legislation is slow, there can be no doubt that we shall ultimately obtain what is required, and that eventually the whole matter will be administered much more satisfactorily and economically than is at present the case. It is obviously very wasteful when one large community which happens to be divided into two or more districts is allowed to spend money upon two or more separate schemes, when one large scheme would have met the requirements of the case much more satisfactorily. The combination of districts is to be desired. The appropriation of the sources of supply and gathering-grounds by one water authority to the detriment of others is to be deprecated; and the enormous expenditure of money, owing to the conflicting interests, that takes place whenever any scheme is brought forward, ought to be avoided. As things stand at present, it is generally acknowledged that reform is required.

ECONOMY OF SCIENTIFIC TREATMENT.

Another even more important point, which has not yet received the general acceptance it will have in the future, is the absolute need of water-supply problems being placed in every case in the hands of those who can deal with the matter scientifically, making use of the most recent knowledge and experience on the subject. It is becoming more and more evident that the engineer must work with the chemist and bacteriologist. If the water supply of London had not received this thorough attention, we should long ago have had to abandon our present sources of supply, and enormous expense would have been incurred in bringing water from a source farther afield. But owing to the fact that the whole question has received the very best attention, we have a combination of districts, a reduction of waste, a water drawn from sewage polluted rivers rendered fit for drinking purposes, and—what would at first sight appear to be quite impossible—brought to a successful fulfilment. The same thing applies exactly in other cases; for though the smaller works are of less importance, regarded collectively, from a national standpoint, they are of greater importance even than the supply of London. It is not sufficient for the engineer to obtain a supply of water free from disease germs, obvious pollution, discoloration, or objectionable mineral constituents. A water which is apparently desirable in every respect may yet cause very serious corrosion in mains, and algal trouble in the reservoirs may be productive of animal and vegetable growths in the mains, and may clog the filters. The conditions need to be much more carefully considered than has formerly been usual; and in this the engineer requires considerable assistance from the chemist and bacteriologist.

RECENT DEVELOPMENTS IN WATER ENGINEERING.

Of recent developments in water engineering, the various methods for the treatment and purification of water are very remarkable. The possibilities seem almost infinite, as if there were no water, however impure, which could not be raised to a high standard of purity by adequate treatment. The growing practice of purifying swimming-bath water, and using it over and over again for months, demonstrates extraordinary possibilities. It has been found that, after many months' use, water so treated is quite equal in quality to the ordinary town supply. The use of the mechanical filter, together with chemical treatment, has increased enormously; and there are many instances of the employment of such filters dealing with several million gallons a day, some of them being in this country. There are also many other filters of various types which have their uses according to special conditions; and the slow sand filter is still very largely employed. Sterilization of water by means of hypochlorite has been very generally adopted in America, and also to some extent in this country, notably as an after-treatment with the mechanical filter; and there is abundant evidence to show that the typhoid death-rate has been lowered, sometimes to zero, as the result of this treatment. Ozone sterilization is in use on the Continent at a good many large installations; and the ultra-violet rays have also been applied to the sterilization of comparatively large town supplies in France. It cannot be said that these methods have made much headway in this country; the reason being that our supplies, as a rule, are not open to the objection of gross pollution. It is, however, notable that Dr. Houston has advised the Metropolitan Water Board to sterilize the flood waters flowing into the storage reservoirs by means of an overdose of lime; and it is also notable that the ordinary lime treatment seems to include sterilization apparently unsuspected hitherto, at any rate in some cases.

REPLENISHMENT OF UNDERGROUND SUPPLIES.

A recent memoir of the Geological Survey, dealing with the wells in the London district, contains the suggestion that the water-bearing stratum—viz., the chalk under London—should be replenished artificially with water; and it is suggested that the water falling upon the impervious stratum surrounding London should be drained into dumb wells, carried down to the level of the Thanet sands. An enormous quantity of water which now runs to waste would thus be collected. This would be stored in the fissures of the chalk, and would raise the level of the water throughout the London district. This level has fallen 100 feet or more within recent times, owing to the enormous amount of water which is pumped therefrom. The advice is based upon Mr. Bryan's experiment at Lea Bridge, where a large quantity of filtered Lea water was run into the wells, with the result that the well supply was materially improved during the drier periods of the year. This is certainly a very interesting suggestion; and the principle probably has many other applications.

PUMPING.

One of the most important changes in connection with water engineering has been in pumping. The use of the high-speed engine, the steam-turbine, the internal-combustion engine, and he electric motor, has resulted in developing the rotary pump. Centrifugal pumps are now largely used, and by running in series are found to be efficient and useful for very high lifts. Producer gas is found to give economical results for large and small powers, and its application is very marked. Further, we have the Humphrey explosion pump, which does away entirely with the engine and most of the working parts of the pump, of which the Chingford installation provides an example near to hand. This pump is also being used for sewage lifting, and apparently has an application for both small and large supplies where a moderate lift is required.

WATER MAINS AND RESERVOIRS.

The use of steel mains is largely on the increase; and though the Local Government Board will sanction only a short-period loan for them, they appear to be taking the place of cast-iron mains in a great many cases. With regard to reservoirs, the chief advance is in connection with reinforced concrete, which is undoubtedly a very economical and useful material; and it is evident that a considerable number of reinforced concrete reservoirs, some of them of large capacity, are being built in this country. In this case again the Local Government Board will not sanction a loan for a long period; but the saving which accompanies the use of this material is so great in some cases as to do away with the inconvenience that would otherwise be experienced from the repayment of a loan during a short period—that is to say, the annual payments are sometimes found to be very little larger in the case of the short loan for the reinforced concrete than for the long-period loan with a masonry structure.

One of the most noteworthy features of recent practice is the increased use of cement injection. We see, for instance, in the Catskill aqueduct, that the tunnels were made of concrete, and that these were rendered water-tight by systematically injecting cement grout under pressure behind the walls of the tunnels. There are several instances where extensive fissures causing leakage under reservoir dams have been satisfactorily filled with cement grout forced in under pressure through borings. The same method is sometimes adopted in order to form masses of concrete for foundations where clean gravel exists under water. Some interesting experiments have recently been carried out with regard to this matter. The rendering of surfaces by means of the cement gun, wherewith cement is thrown out under pressure from a nozzle and applied to the surface to be treated, is worthy of note. The method has also been used for lining large pipes.

With regard to the storage reservoirs and the construction of

dams, recent progress shows that very much more attention is being bestowed on geological considerations than was formerly the case, and that it is worth while to look more closely to preliminary investigations with regard to the site of the reservoir, and prove by every possible means its suitability before starting the work. Dr. Houston has shown in the case of London that storage reservoirs may be used for water purification; it being found that a few weeks' storage is sufficient to kill or to devitalize harmful germs. The method is hardly likely to be very generally applied, because the water probably does not need such purification; and, moreover, the cost of constructing the reservoirs makes the system prohibitive in the majority of cases. There are also possibilities of trouble with regard to algal growths in the water.

PRIVATE SUPPLIES.

One of the most remarkable points that may be noted regarding the present system of water supply in this country is the manner in which, in the middle of a water district, the private individual is at liberty to make his own well and obtain his own private supply. The fact that in London there are a very large and increasing number of wells supplying works, institutions, offices, and the like, in the middle of the district of the Metropolitan Water Board, suggests that there is something amiss. It seems like waste of energy in this duplication of works; and while the private owner relies upon the public mains for the protection of his building in case of fire, he appears to be exempt from the responsibility of paying for it if he has his own private wells. Interesting as all these private supplies may be, there seems to be something amiss in the general control of affairs that they should be necessary.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

High-Pressure Distributing Mains or High-Pressure Lighting Mains?

SIR,—I am much interested in your articles of March 31 and April 7 respecting high-pressure gas systems, in which you name several towns using mains for high-pressure gas. As I understand it, most of the places referred to are simply using mains for high-pressure lighting up to about 2 lbs. pressure, and not for high-pressure distribution. To lay a main for a few high-pressure lamps is an extremely unnecessary extravagance, as I view it.

If you could induce your correspondents to give you particulars such as the purposes for which their mains are laid, and the pressures at which they are employed, in my opinion such useful information would help forward the question of adequate and constant pressure at the consumers' appliances, whatever the demand, more than anything else that can be suggested at the present time.

The objects of high-pressure distribution are to distribute gas not only cheaply but efficiently; and there are no other means of doing this than through high-pressure mains.

GEO. HELPS.

Nuneaton, April 9, 1914.

Low-Temperature Carbonization.

SIR,—I have read with interest the comments of Mr. L. R. Richards on my article on "Low-Temperature Carbonization."

It is evident that he speaks with the enthusiasm of an interested party. In the first paragraph he states that the thermal losses of a coal-fire amount to 80 per cent. While not wishing to question Mr. Richards' figure, I should like this statement to be amplified. I agree that, on his calculation, the value of the semi-coke may be 52s. per ton; but, unfortunately, we do not always get price for value. My reason, however, for stating that the semi-coke would have to be sold at a price less than that of coal, is very obvious. Coal has the market at present; and in order to displace it some material advantage will have to be offered. When a consumer buys a ton of coal, no thought of how many B.Th.U. he is going to get out of it enters into his head; and I still contend that, with the exception of enthusiasts, it will be a difficult matter to place the semi-coke on the market in any quantity. Mr. Richards says that "the supply will not overtake the demand until the use of coal in its raw state is a thing of the past." I would ask him what is going to happen in the meantime.

My reason for taking a coal containing 20 per cent. of ash was on account of the fact that it has been stated so frequently that low-grade coals might be used for low-temperature carbonization; and I wish to make it quite clear that if low-grade coals are used, the resulting coke is of a very inferior character. In your issue of April 8, 1913, you gave a description of the Richards process; and on p. 83 Mr. Richards points out that in his process "the coal shall be washed and as low a standard of ash as is possible shall be established." I will admit that, if this standard is taken, my figures are on the high side; but in many cases that I have come across the figures apply quite well.

With regard to the value of the gas to a gas engineer as being 25s. per ton of coal carbonized, I have made practically no allowance for distribution costs. It would perhaps be a fairer comparison to make some allowance for this. I also agree with Mr. Richards that the best method of comparison is by means of a balance-sheet, taking into account revenue derived from all sources. Certainly such balance-sheets have been issued on behalf of low-temperature carbonization; but it has to be remembered (as I pointed out in the original article) that these are based entirely on a hypothetical plant, and that the results given are obtained on a small test-plant.

In conclusion, I would add that I appreciate the friendly spirit of Mr. Richards' criticism, and would assure him that I should be only too pleased to see the successful introduction of low-temperature carbonization an accomplished fact. I must repeat, however, that in my opinion it will take an immense amount of argument to induce the ordinary public to buy coal or semi-coke respectively on account of its B.Th.U.

"AMICUS."

April 8, 1914.

Gas-Making at Koenigsberg.

SIR,—We have read in the "JOURNAL" for March 24 an article according to which the Koenigsberg Gas-Works use the so-called direct process of Koppers for the recovery of tar and ammonia. This is incorrect; and we would therefore request you to inform your readers of the error of the author.

The following is the process of gas production followed here: The gas is produced in thirty-five Koppers combination ovens. From the ovens it passes into a dry main; and thence in insulated pipes to two large cylindrical coolers, in which the crude gas is subjected to fine sprays of tar from a Körting spraying apparatus. The gas next passes into condensers, which in the lower half contain water-cooled tubes for the passage of the gas, and above are ordinary air condensers. The gas travels from these through a Pelouze and Audouin apparatus, then through Jaeger exhausters, and so to the cyanogen purifiers (Bueb process), and the Walther Feld ammonia and sulphuretted hydrogen washers. The preparation of the gas is completed by ordinary dry purification with Lux material. It is then measured by one wet and one dry meter, passed to the holders, and so to the town.

E. KOBBERT,
Manager of the Municipal Gas-Works.

Koenigsberg, April 3, 1914.

SIR,—It is with regret that I have to draw your attention to an error which crept into my article in the "JOURNAL" for March 24.

In connection with my description of the Koppers chamber-oven plant at Königsberg, I inadvertently gave the impression that the Koppers direct recovery process was also in operation there. This is incorrect, as the process in operation for the recovery of the ammonia is the Feld process. The Koppers process is in operation in connection with combination ovens at other places in Germany, but not at Königsberg.

The offending sentence should have read: "In connection with combination ovens similar to those at Königsberg, the whole of the gas produced is treated by the Koppers direct-recovery process."

G. STANLEY COOPER.

Sheffield, April 6, 1914.

Charges for Power Gas at Burton-on-Trent.—A scale of charges has been fixed by the Gas Committee of the Burton-on-Trent Corporation for gas consumed for motive power or other manufacturing purposes, in the districts of Rolleston, Tutbury, and Hatton. The new scale applies to quantities of a million cubic feet per annum and upwards, supplied to one premises, and registered by a separate meter. A consumer who wishes to take advantage of the scale, will be required to pay for all additions and alterations to his pipes and fittings rendered necessary by his having a separate meter, and also for the fixing of the meter. Further, if, in the opinion of the Committee, the gas estimated to be used will not be sufficient to justify them in providing a separate meter to register it, they may require the consumer to provide his own meter.

Bombay Gas Company, Limited.—On Thursday of next week the shareholders of this Company hold their annual meeting, when the Directors will report that there was last year an increase in the sale of gas both to private consumers and for the public lamps—the additional revenue from this source being £3606. There was also an increased return from residual profits of £1765. The profit for the year (including the payment on account of interest, and the profit on exchange) amounted to £24,117—making, with £5744 brought forward from the preceding year, £29,861 available for dividend. After allowing for the interim dividend paid last November (£8400) and placing £760 to the reserve fund there remains £20,701, out of which the Directors recommend a dividend of 4½ per cent. (less income-tax), making 7½ per cent. for the year, with £8101 to be carried forward.

A Middleton Editorial Criticism.—The following editorial comment in connection with the last meeting of the Middleton Town Council is culled from the "Middleton Guardian:" "The discussion revealed an unfortunate spirit of antagonism between the Gas and Electricity Departments. Consciously or unconsciously, the Gas Committee seem to have a knack of irritating. They are now going to say that people who possess gas-stoves must use a minimum quantity of gas. This is easy of accomplishment by people who have gas for lighting purposes, where all their gas goes through one meter; but it is an imposition to say that the person whose house is lighted by electric light shall be compelled to adopt the same minimum. Then, to make the case worse, Alderman Townsend, the Chairman, said the Committee would use discrimination before they took any stoves away. We do not care for this 'discrimination!'"

Hiring Prices for Cookers, &c., at Rochdale.—Matters in connection with the new show-room were under the consideration of the Rochdale Gas Committee at their meeting last week. An anomaly has been that the charge for the loan of certain types of cookers which have been previously used has been higher than that of those of other makes, and on the recommendation of the Sub-Committee a revision of these charges was made. This, however, only relates to cookers applied for from the present time; no reduction will be made to consumers who are already using cookers. The Gas Committee have agreed to a proposal that people who desire it may have their incandescent lights kept in thorough order on payment of 6d. per light per quarter—exclusive, of course, of the cost of new mantles. Apart from the possible revenue to the department, the intention is to show that in cases of faulty lighting the fittings, and not the gas, are to blame.

REGISTER OF PATENTS.

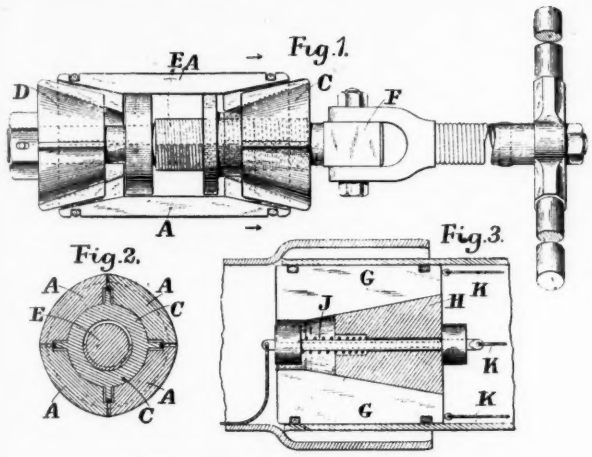
Caulking Thin Metal Pipes.

BALL, F. L., of Maidstone.

No. 6637; March 18, 1913.

This invention relates to apparatus for caulking pipes when made of such thin material that, in the caulking of a spigot and socket, the hammering of the caulking material into the socket "frequently crumples and deforms the pipe within it, thereby forming an annular protuberance in the bore of that portion of the pipe which is received in the socket, and preventing a tight joint being made." The invention relates to a method of overcoming this difficulty by introducing a collapsed expansible mandrel into the interior of the pipe, expanding it therein to strut the pipe wall, and then forcing the caulking material into close contact with the exterior portion of the pipe thus strutted.

Fig. 1 is a side elevation (partly in section) of one form of expansible mandrel; fig. 2 is a cross section; while fig. 3 is a longitudinal section of an alternative construction of mandrel.



Ball's Caulking Appliances for Thin Pipes.

The operation of the device shown in figs. 1 and 2 is as follows: When the tubes are placed in position and the mandrel inserted from the open end to a position inside the joint, the mandrel is expanded by rotating a hand-wheel, which causes the screwed part E, on the spindle attached to F, to displace the cone C, relatively to the cone D. By causing them to approach one another, the segments A are opened-out until they form a tight fit in the tube. Caulking material is then forced into the joint and caulked in the usual manner; and "the tube is not damaged or dented in the process owing to the support it receives from the mandrel." When the caulking is finished, the reverse rotation of the spindle causes the wedge members C and D to move apart, so that segments A can be drawn together, by the rubber bands or springs, until the diameter of the mandrel is sufficiently small to permit its withdrawal from the free end of the pipe.

The construction illustrated in fig. 3 is adapted for use with curved pipes or when it might not be possible to insert the particular type of mandrel above described. The segments G form a hollow cylinder, which is tapered on its interior in one direction only. The tapered wedgepiece H is arranged to fit inside the segments and to expand them to the desired diameter. The wedgepiece is provided with a central bore through which extends a rod J, having a head formed on it at the narrow end of the wedge. A spring taking a seating in a recess in the end of the wedge normally holds the head off the wedge. Rubber rings may be arranged to hold the segments together, as in the previous construction.

The operation of this form of the invention is as follows: The segments G are inserted round the wedge H into the spigot end of the pipe section to be next placed in position, and are hammered in—the wedge being held by tension on a cord holding the head up against it. The cords K are passed through this section so as to be accessible at its open end, and it is brought into position in the socket of the pipe section already laid. The joint is then caulked in the usual manner; and when finished the expanded mandrel is removed by pulling on the cord K, attached to the rod J. The head then strikes against the narrow end of the wedge and slackens it. The wedge itself may then be withdrawn, and the segments G are drawn together by the bands, to occupy a smaller diameter, when they may be withdrawn from the pipe.

Removing Ammonia from Gases.

MARR, J., of Sheffield.

No. 6291; March 13, 1913.

The main object of this invention in the dry distillation of coal is to provide an effective method for preventing the deposition of water in the sulphuric acid in the saturator and the consequent dilution of the acid to such an extent as to prohibit the formation of solid ammonium sulphate.

The usual methods employed for the removal of ammonia from gases produced in the destructive distillation of coal having been referred to in the specification, the patentee proceeds: An examination into the condition of the gases has led to the method employed in the present invention. On mixing the partially purified gases with the steam and ammonia from the distillation column employed, there is an interchange of heat until the equilibrium temperature is reached. The mixture of ammonia vapour and steam at about 100° to 105° C. falls in temperature, while the residual gases with which they are mixed rise in temperature. The resultant mixture is in a supersaturated state; and, unless means are taken to avoid it, the gases would carry forward with them in their passage to the saturator an amount of water-fog corresponding to their degree of supersaturation. The result of this would be that, on opening in contact with the sulphuric acid of the saturator, water would be deposited and the bath diluted to such an extent that solid salt could not be obtained.

In practice, however, owing to the heat of formation of ammonium sulphate being positive, the gases may be allowed to come to the saturator in a slightly supersaturated state without water being deposited—according to the amount of ammonium sulphate formed per unit of gas passing through the saturator and the degree of supersaturation of the gases. The amount of ammonium sulphate formed per unit of gas is usually too small, however, to allow the gases to come to the saturator after adding thereto the whole of the mixture of ammonia vapours and steam from the distillation column unless some method is adopted to avoid the deposition of water in the saturators.

According to the present invention, the ammonia and steam are added to the gases without any prior cooling or concentration, and then the resultant mixture is passed through a water-separator to remove the water-fog from the gases. Such a water-separator may consist of a steam drier, or any other suitable apparatus, wherein the gas is made to come in contact with a series of baffle-plates, or arranged to pass through in spiral fashion—causing the gas to impinge on the casing, or passing the gas through a series of plates in which are arranged a number of small holes, or in any other suitable way—all with the object of collecting the minute globules of water and not allowing them to pass on to the saturator with the gas.

After passing through the separator, the gases are conducted to the saturator to fix the ammonia in the usual way.

The passing of the gases through the separator before going to the saturator will, it is said, have the additional advantage that the last particles of tar and other impurities would be caught in the separator, thereby producing a cleaner salt in the saturator than in the processes hitherto practised.

The advantage of this method of treating ammonia-containing gases prior to their entry into the saturator over previous processes, it is claimed, is as follows: With crude gases having the same ammonia content and cooled to the same degree, a greater margin of temperature (to allow for radiation loss) between the actual and required temperature of the liquid in the saturator is attained with saturator gases, as in the present process, than with supersaturated gases obtained in other processes. The reason for this is that less water vapour is carried into the saturator by saturated gases per unit of gas passing through the saturator. With crude gases having an average ammonia content treated in the manner described, cooled to 30° C., the margin of temperature in the present process is 60 per cent. greater than "the best margin obtained with other processes." Further, the present process, it is said, has "the advantage that the quantity of liquid treated in the distillation column per cubic metre of gas is considerably less than with other processes, and in addition cooling and/or superheating of the gases is avoided, no cooling or concentration of the ammonia vapours is required, and, owing to the gases passing through the saturator being in a purely saturated state, the process is less dependent upon the ammonia content of the gases than other processes in which the gases pass through the saturator in a supersaturated state."

Argand Gas-Burner.

LINLEY AND CO., and OWENSMITH, W. H., of Birmingham.

No. 11,819; May 21, 1913.

The inventors propose to provide a burner of the argand type suitable for use with the high-pressure gas consumed on railway rolling stock. The burner consists of a metal body, threaded internally at its upper part to receive a cylindrical steatite top having small perforations for the passage of the gas. Holes are drilled through the steatite at an angle so that the current of gas emerging from them takes a spiral instead of a vertical course in the annular chamber above, and thus emerges evenly at the perforations in the head, which tends to obviate any forking of the flame. The lower portion has its top part countersunk so as to allow room for the gas to pass to the holes; and there is a regulating screw fastened by a set-screw.

Gas-Burners for Heating Bakers' Ovens.

OUDEVILLE, F., of Paris.

No. 15,952; July 10, 1913. Convention date, Oct. 16, 1912.

This apparatus for heating bakers' ovens by gas provides a "self-contained and complete apparatus, which can be bodily removed from or placed into the furnace of existing bakers' ovens."

The gas-distributing chamber is supplied with gas for combustion, and from the chamber a plurality of gas-supply pipes proceed, the delivery ends of which just enter within the open rear of a box-like structure, termed an air-receiver. From the closed forward face of the air-receiver (which is at a distance from the delivery ends of the gas-supply pipes) mixing pipes extend; the gas firing or being ignited at the forward ends of the mixing pipes. There is a slidable plate which can be brought nearer to or further from the open rear of the box-like air-receiver to restrict more or less the entrance of air; and wire-gauze tubes extend from the rear of each mixing pipe to around the delivery end of each supply pipe.

In one arrangement of the apparatus a plurality of gas-burners have been connected in fan-like order, arranged at opposite corners of the furnace; the air-inlet end of each burner extending into an air space constructed in the wall of the oven, the admission of air to which space is regulated by a damper. In another proposed construction

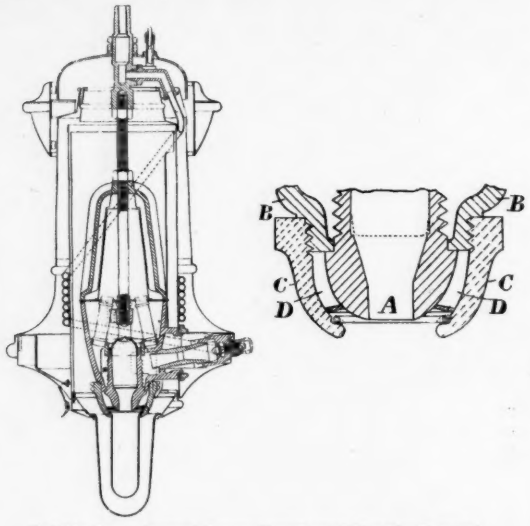
there is a gas-distributing chamber from which a plurality of gas-pipes extend, which pass through a common air-chamber, and each gas-pipe has its delivery end within a tube where the gas is fired. In a third construction there is a box-like air-chamber, open at its base, with a plurality of mixing pipes extending from its closed top; and the gas-supply nozzles (one for each mixing pipe) extend from a common supply pipe, but are all located within the box-like structure.

Gas-Lamps.

KEITH, J. & G., of Farringdon Avenue, E.C.

No. 14,489; June 23, 1913.

This invention has for its primary objects to afford increased protection against overheating of the burner-nozzle, &c., and also to provide a simplified suspension for the mantle. It is a modification of patent No. 28,360 of 1907, where was described a high-pressure inverted incandescent gas-lamp provided with a gas and air heater to which was fitted a nozzle of substantial cross section, and composed of good conducting metal on which was a non-conducting ring serving to support the mantle. In accordance with the present invention, the ring is supported from the underside of the heater, and serves to shield the lower extremity of the heater.



Keith's Incandescent Lamp-Nozzle and Mantle-Support.

The nozzle A is of good conducting metal and substantial cross section, located at the mouth of, and in thermal contact with, the gas and air heater B. It is preferably of hemispherical form, "to ensure adequate conduction of heat from the tip." A ring C of non-conducting material (conforming in shape with the nozzle—*e.g.*, shaped as a cup having a central aperture) is supported from the heater. There is thus afforded between the inner wall of the ring and the outer wall of the nozzle an annular space D closed at its upper end, "such as results in certain prior constructions in which the ring is supported by a socket on the burner." Important to the invention is the protection of the lower portion of the heater B against overheating, "which is favourable to the performance by the lower portion of the heater of its function of extracting heat from the nozzle." The soft mantle employed, instead of being supplied with a non-conducting ring, as usual, is fitted with a light ring, preferably of wire, attached to the upper end of the mantle fabric; the diameter of the ring exceeding the diameter of the aperture in the ring C. To attach the mantle, it suffices to unscrew the ring from the heater and drop the fabric through the aperture in the ring from above—the ring being allowed to rest in the recess, and the mantle being then formed and shaped in the usual way, before the ring is replaced.

Apart from the economical considerations involved in the substitution of a light ring for the usual non-conducting mantle ring, the patentees claim that the mantle suspension described presents the advantage that, in the selection of a mantle, the user is not limited to the employment of mantles having a diameter at the upper end exceeding that of the bore of the nozzle, but may employ a mantle of any practicable diameter. The top of the mantle, being exposed directly to the flame, is hardened more satisfactorily than it is in the case where it is fixed on the outside of an ordinary mantle ring, and so shielded from the flame. With the present arrangement, therefore, the use of a hardening liquid may be dispensed with.

Measuring the Pressure of Gases.

PILLER, P., of Düsseldorf.

No. 16,130; July 12, 1913. Convention date, July 12, 1912.

This apparatus for measuring the pressure of gases consists of a pivoted beam carrying the recording pencil, which is actuated by one or more mercury containing vessels, suspended from it and moved by being made heavier or lighter by a flow of mercury to or from each other, or to or from a separate vessel. Means are provided whereby the necessity of correcting pressure measurements to allow for the variation of atmospheric conditions is eliminated by adapting mercury or aneroid barometers to readjust the level of the mercury disturbed by this variation.

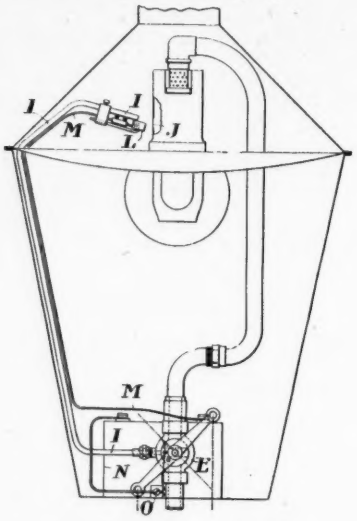
Three forms of the pressure meter are illustrated by way of example in the specification.

Igniting Gas-Burners.

CARPENTER, C. C., of Old Kent Road, S.E.

No. 16,388; July 16, 1913.

This invention has reference to gas-lamps employing for igniting them a "spit fire"—that is, a jet of gas which is momentarily projected into the lamp during the turning on of the gas.



Carpenter's Gas-Lamp Igniter.

The lantern is entered at the bottom by a gas-supply pipe which extends upwards through the reflector, and bends over to support the lamp. In the inlet pipe is the gas-cock, which comprises a barrel E and plug furnished with a lever. In the barrel at right angles to the main bore of the cock is a passage to which is fitted a pipe projecting in an upward direction through the reflector, and terminating in an approximately horizontal portion opposite a hole J in the flue of the lamp. The bore of the plug is so formed that both in the closed position of the cock (as illustrated), and in the fully open position when the gas supply to the burner is turned on, the pipe I is closed. When, however, the cock is only partly open to the burner by the partial turning of the plug, the passage to the pipe I is also open.

In this way a momentary jet of gas from the pipe into the lamp is provided during the act of turning the plug of the cock by means of the lever. To ignite this "spit fire," an electric igniter L is provided, consisting of a platinum coil or other filament in "a fire-clay crater which protects the filament from destruction by heat." The crater is supported upon the end of the pipe I, in such a position that the jet of gas shoots along an open path across the mouth of the crater on its way to the hole J in the flue. One end of the coil is connected by an insulated conductor M to a terminal of the battery N; while the opposite end is connected to the pipe I, which acts as a return conductor to the barrel of the cock. The second terminal of the battery is connected electrically to an insulated terminal O which carries a contact plate. There is a pin on the lever which is adapted to rub against the plate when the lever is in about its middle position. The contact between the pin and the plate completes the battery circuit, and the passing current heats the igniter coil precisely at the same moment that gas is passed from the pipe I into the hole of the lamp flue. The jet is thus ignited, and by it the burner of the lamp. The turning of the plug of the cock to full bore moves the pin away from the plate, and the igniter is thrown out of action.

Incandescent Gas-Mantles.

ROBIN, J. I., of Great Titchfield Street, W.

No. 22,485; Oct. 6, 1913.

The object of this invention is to apply stiffening fluid to incandescent gas-mantles "which may be accurately and rapidly carried into effect while at the same time the stiffening fluid shall be applied evenly to the mantles, and the material of the latter shall be thoroughly impregnated."

The process consists in forcing the fluid against the material of the mantle under pressure, the mantle being given a rotating motion relatively to the fluid-applying means. The invention also comprises: (1) A process for applying stiffening fluid to incandescent gas-mantles which consists in rotating the mantle in front of a nozzle through which the stiffening fluid is injected by means of compressed air or gas. (2) Apparatus for applying stiffening fluid to mantles, comprising nozzles through which the stiffening fluid is sprayed under pressure, and means for holding and rotating the mantles or material for forming them adjacent to the nozzles.

In view of the increasing popularity of semi-direct lighting, attention may be called to a useful booklet now being issued by Messrs. Falk, Stadelmann, and Co., Limited, dealing specially with the appliances available for the utilization of gas in connection with this system of illumination. Illustrations are given of gas-lamps suitable for the interior lighting of offices, shops or show-rooms, and private houses; and it is pointed out that they can all be fitted with the pneumatic distance lighting switch.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS.

The following progress has been made with Bills:—

The Abertillery Water Board Bill was read a second time and committed.

The Middlesbrough Corporation Bill was reported with amendments.

It was reported that the further Standing Orders with regard to the Alliance and Dublin Gas Bill have been complied, and the Bill was committed.

The North Staffordshire Railway Company has presented a petition against the Stone Gas and Electricity Bill.

The petitions of the London and North Western Railway Company and the Great Eastern Railway Company against the London County Council (General Powers) Bill, of the Great Eastern Railway Company and the London and South Western Company against the City of London (Various Powers) Bill, and of Arthur John Dorman against the Tees Valley Water Bill have been withdrawn.

Local Government Provisional Orders Confirmation Bills—Nos. 1 & 2.

These Bills were before the Unopposed Bills Committee of the House of Commons last Tuesday, and were ordered to be reported for third reading. They were subsequently read the third time and passed. Included in the No. 2 Bill are the following Orders: Haverfordwest, which authorizes the Urban District Council to borrow up to £5000 for the purposes of their gas undertaking, in addition to the sum of £10,000 previously authorized; Maryport, which grants additional borrowing powers to the Council of £15,000 for gas purposes; Southampton, which grants additional borrowing powers to the extent of £75,000 for the purposes of the Corporation's water undertaking.

Inverness Water and Gas Provisional Order Bill.

This Bill, to confirm a Provisional Order under The Burgh Police (Scotland) Act, 1892, relating to Inverness Water and Gas was presented by Mr. M'Kinnon Wood, read the first time, and referred to the Examiners.

DEAL AND WALMER GAS AND ELECTRICITY BILL.

HOUSE OF COMMONS COMMITTEE.—Tuesday, March 31.

(*Before Sir* HARRY SAMUEL, *Chairman, Mr.* ORDE-POWLETT, *Mr.* ROBINSON, *and Mr.* FRANCE.)

This Bill is to empower the Deal and Walmer Gas Company to supply electricity, to supply gas for power purposes, raise additional capital, apply the sliding-scale, and create benefit funds for the employees.

Counsel for the promoters were Mr. HONORATUS LLOYD, K.C., and Mr. TYLDESLEY JONES. The opponents were the Deal Corporation, represented by Mr. G. J. TALBOT, K.C., and Mr. BEVERIDGE; the Walmer Urban District Council, represented by Mr. ST. JOHN RAIKES; the Eastry Rural District Council, represented by Mr. W. J. JEEVES; and the South-East Kent Electric Power Company, represented by Mr. S. MORSE (Solicitor).

Mr. HONORATUS LLOYD said the main objects of the Bill were to sanction the supply of electricity within the existing gas limits, prescribe a new quality and method of testing the Company's gas, make certain provisions with regard to the supply of gas for power purposes, authorize additional lands for gas purposes, an electrical generating station, and a railway (the latter to avoid carting coal), raise additional capital, apply the sliding-scale, and provide for the institution of benefit funds for the employees. The Company was formed in 1852, and was incorporated under the Companies Acts in 1862. In 1864, it became a statutory concern; the capital authorized being £14,000 of 10 per cent. maximum stock, £1750 of 4 per cent. maximum stock (representing capital spent out of revenue), £15,000 of 7 per cent. stock, together with borrowing powers amounting to £7000. At the same time the maximum price of gas was fixed at 6s. per 1000 cubic feet. The Company's next Act was in 1902, when they were authorized to convert and consolidate their capital into a uniform 5 per cent. stock amounting to £50,400, and at the same time to raise £50,000 of additional 5 per cent. capital; making a total of £100,400. By the 1902 Act, also, the Company were authorized to supply 15-candle gas; and a clause was inserted giving the right to apply to the Board of Trade for Electric Lighting Provisional Orders. The capital issued was £39,311 18s., and loans of £7000 had been taken up. The Company at the present time had unissued capital and loan powers to the extent of £55,977 18s., which sum was almost sufficient to carry on the gas undertaking for the usual period of about ten years. Of the capital requirements sought in the Bill, however—viz., £25,000—only £5000 were allocated to the purposes of the gas undertaking; the remainder being for electricity purposes. The Company's area of supply was Deal and Walmer and a few outside districts, and the sale of gas at present was nearly 100 million cubic feet per annum. The price had been gradually reduced. It was 3s. 9d. to ordinary consumers in 1905, 3s. 6d. in 1906, 3s. 5d. in 1909, 3s. 4d. in 1911, and 3s. 3d. in 1913, with 5 per cent. discount to customers taking over 50,000 cubic feet per quarter. The Company, as already stated, was a maximum-price undertaking, and had been able to pay maximum dividends ever since 1892. There was, however, still outstanding a sum of £4158 in respect of back-dividends. The works, which were situated in Deal, were in a fair condition with the exception of the carbonizing plant, which was out of date, and would shortly be renewed. Neither Deal nor Walmer was very large; but both were increasing gradually. There were also some people who believed that there were going to be some considerable developments due to the Kent collieries. Dealing in detail with the proposed electricity powers, Counsel pointed out that, when the Bill was drafted, it asked for electricity powers in the existing gas limits, and also in Worth and Sandwich; the reason for this being that the two latter districts had also been included in schemes promoted some time earlier by others. These two districts, however, objected; and now it was only asked to be allowed to supply within the existing gas limits. The area was one in which it was apparently common ground that there was a demand for electricity. The only objection on the part of the opponents was that it should not be in the hands of a gas company; the fear apparently being that it would be to the interest of the gas company to push gas as against electricity, and so squelch competition. He could only assure the Committee that this was not the case. The district, as a matter of fact, was one which had been particularly sought after by electrical companies. In 1902, the Kent Electric Power Company obtained an Act for supplying in bulk to authorized distributors and to users for power purposes; the only lighting supply being that power users could take up to 20 per cent. of their demand for lighting. In 1903, an Electric Lighting Provisional Order was granted to the Kent Electric Power Syndicate for Sandwich, Deal, Walmer, and the rural district of Eastry. Nothing was ever done; and in 1908 the Order was revoked. It contained a clause, however, that if the local authorities applied within twelve months of 1903 for a Provisional Order, the Syndicate should not exercise its powers. The Walmer Council applied in 1904; but this Order also was revoked in 1909. In the meantime (in 1906) the Kent Electric Power Company came to Parliament and obtained an alteration in their powers authorizing them to supply in detail, as well as in bulk. Therefore at the present time the Power Company could supply in the Gas Company's area. These powers, however, were given on the distinct understanding that they were not to prejudice any applications for electric lighting Provisional Orders by others. In spite of all this, nothing was done towards giving a supply of electrical energy. In 1911, the Kent Power Company transferred their powers in the Deal and Walmer district to the South East Kent Power Company; the transfer including a provision that the latter Company should spend £25,000 in a given time, or their powers were to become void. No such sum, however, had been spent. The South East Kent Company were associated with the Kent collieries, and had erected a generating station at the colliery at Tilmanstone, five miles away. In spite of all these applications, up to 1911 only the Power Company remained with authority. But they did nothing beyond putting up a power station at the colliery, and had taken no steps whatever to give a supply. In that year, the Sandwich, Deal, and Walmer Electric Supply Company also obtained a Provisional Order to supply in these three districts. But, again, although a certain amount of money had been spent in preparations, nothing of a practical nature had been done; and so the district was once more left without electricity, notwithstanding that at the present moment the Power Company and the Sandwich, Deal, and Walmer Company both had powers. The Provisional Order of the latter was liable to be revoked at any time. Therefore the Gas Company, by arrangement, were proposing under the Bill to take over the powers of the Sandwich, Deal, and Walmer Electric Supply Company for £1100, and have that Company's Provisional Order revoked. The argument that it was bad for the public to entrust a gas company with electric lighting powers might have held good some years ago; but there were now many examples of this being done by Parliament with great success. He need only, for the moment, mention Ascot, where it had been proved to be greatly to the public benefit. The Gas Company were in a much more favourable position to deal with an electricity undertaking in a small place than an independent electric supply company. Many of the staff were already available; and the Company were able to use their own gas for driving the dynamos. The only question was whether the Gas Company were *bonâ fide*. There had been a feeling in the district that the object of the Gas Company was merely to secure the powers and lock them up. As evidence of this not being the case, he was willing to come under penalties, which none of the other promoters had had put upon them. For instance, instead of having to lay mains in the compulsory area within three years, he reduced the period to two years in Deal and Walmer; otherwise the powers should be revoked. A supply must also be given in the outside area within five years. If there was a case in which the Gas Company should be given electric lighting powers this surely was it, having regard to the past history. It was said in the petitions against the Bill that the Company should have applied for a Provisional Order and not for an Act. But the Company in any event were coming to Parliament this year for powers to bring the gas undertaking up to modern legislative standards; and it was idle to suggest that they should have proceeded by Bill for the one and by Provisional Order for the other. The result would have been a prospect of five fights instead of two, which would have been very expensive and bad for the consumers of gas. When the Bill was deposited, it contained a purchase clause on the lines of that inserted in the Herne Bay Gas and Electricity Act of last year, providing that, if the local authorities purchased the electricity undertaking, they should also purchase the gas undertaking. As Deal and Walmer objected, however, this had been taken out, and now only purchase powers over the electricity undertaking remained. The other important provisions included a reduction in the candle power from 15 to 14, and the "Metropolitan" argand No. 2 burner was prescribed; while the proposal to take additional lands referred to an extension of the gas-works on the existing site, and land in order to build a short line to join-up with the railway so that coal could be brought direct into the works. Under clause 52 of the Bill, £25,000 of additional capital was asked for, with one-third borrowing powers. Of this, only £4000 was needed for the gas undertaking; the remainder being for electricity purposes, with the proviso that if the electricity powers were not exercised the additional capital in respect of the electricity undertaking should not be raised. Again, the Company were asking to be changed from a maximum price to a sliding-scale undertaking, with a standard price of 3s. 3d. As to the future, the carbonizing plant was about to be reconstructed, with the result that manufacture would be cheaper than now. The effect of the railway would also be to reduce expenses, and some thing more in this direction was hoped for from the use of Kent coa

with which experiments were being carried out. It was said in the petitions that the standard price of 3s. 3d. was too high. The Company, having considered the possibility of reducing the cost of manufacture in the future, were prepared to offer a neutral zone between 3s. 3d. and 3s.; so that the Company would not divide any higher dividend than the standard until the price to consumers was below 3s. Objection was taken to clause 25, giving the right to supply power gas. He was inclined to think that, if the Company obtained their electricity powers, this clause would not be required, and that there would be no necessity to lay mains for the purpose. It was also said that the additional capital powers were excessive, and that, having regard to the unusually large reserve fund at the present time, there was no necessity for a special purposes fund and a reserve fund. These latter, however, were Model Clauses in the case of sliding-scale companies, and the existing reserve fund was automatically swept into the new reserve fund. While the Deal Corporation suggested that they were the proper authority to give a supply of electricity if one was needed, the Walmer Council did not make this point. The Eastry Rural District Council complained that there was no compulsory area in their district. The South East Kent Power Company raised the question of a supply in bulk from them, and objected to the Gas Company erecting their own power station. Of course, when the time came the Gas Company would consider whether it was more profitable to take in bulk or erect their own generating station. Not desiring to be tied to the Power Company, however, he wished to have power to erect a separate generating station.

Mr. *E. H. Hinds*, a Director of the Gas Company, and a member of the Walmer Council, said he was also a shareholder in the Sandwich, Deal, and Walmer Electricity Company, which was promoted solely with the object of bringing a supply of electricity into the district; the absence of a supply having materially retarded progress. After the Sandwich Company obtained their Order in 1911, several electrical firms and financiers sent down experts to inspect the district. Though they were all in favour of the undertaking as likely to be a commercial success, none of them regarded the venture as being large enough to justify their taking it up. Consequently he brought the matter to the notice of the Directors of the Gas Company, who agreed to take it up and to pay the Electric Company £1100 for their powers. There were 14 private electrical installations already in the district, and it would be cheaper to take a supply from some public source. The Gas Company were using a fair quantity of Kent coal at their works; but the make of gas from it was not so satisfactory as from Durham coal. As to residuals, the coke was satisfactory; but not so the other items. Under the proposed sliding-scale, six-sevenths of any reduction in the cost of manufacture went to the consumer.

Mr. TALBOT, in his cross-examination on behalf of the Deal Corporation, argued that, if the electric undertaking did not pay, it would be a charge upon the consumers of gas. Witness, however, said he had every confidence in the commercial prospects of electricity supply in this area. People had refused to come to stay in the district because of the absence of electricity. Counsel also challenged the Company's sale of gas per ton of coal carbonized, which he said was only 8475 cubic feet, and "getting worse" Indeed, it was alleged that all the Company's figures were bad, and that by proper management gas could be sold at 6d. per 1000 cubic feet less than at present.

Mr. RAIKES, for the Walmer Council, put it that there were 18 members of this body, of whom five were interested in the Gas Company, and that it was only these gentlemen who favoured the present scheme. Witness, however, said that this was not the case; the point being that a certain vote referred to by Counsel was only to oppose the Bill on details, and not the scheme itself. Counsel next suggested that all the Directors of the Gas Company were very old and hardly capable of appreciating the importance of this proposal. He also raised the question that, as London financiers would not touch the electrical scheme, the local Directors were not justified in taking it up.

The CHAIRMAN asked if it was the case that the Gas Company had been asked to take the scheme up; witness at the same time believing that it could not be made profitable.

Witness said most emphatically this was not so. The London companies had merely said that the scheme was not large enough, although they regarded it as a sound one from the paying point of view.

In answer to Mr. MORSE and Mr. JEEVES, for the other opponents, witness said that the sum of £1100 which the Gas Company were to pay the Electrical Company included a profit.

In re-examination, Mr. TYLDESLEY JONES said it should be clearly understood that the make of gas mentioned by Mr. Talbot was with Kent coal. Witness said this was so. The ordinary make was rather over 10,000 cubic feet per ton of coal carbonized.

Mr. *J. Edgar*, an Alderman of Deal, said he also was interested in the Electric Supply Company, and agreed with the previous evidence as to the desirability of a supply being available.

Wednesday, April 1.

Mr. *F. H. J. Hayward*, a member of the Deal Corporation and an ex-Mayor of the town, said he had sold shares which he once held in the Gas Company in order that he might be free to take part in the debates on the electricity question. He did not believe there was any chance of the Corporation taking up the matter, and agreed with the Gas Company having the necessary powers under proper conditions. As a builder, witness said he had experienced difficulty in disposing of property owing to the absence of the electric light.

Mr. BEVERIDGE, in cross-examination, said the Deal Corporation was at present in negotiation with the South-East Kent Power Company for a supply.

Mr. RAIKES questioned to the effect that witness had been able to let or sell all his houses, notwithstanding the absence of electricity.

Mr. MORSE, for the South-East Kent Power Company, raised the question of public lighting, and suggested that the Corporation would be in the hands of the Gas Company if the Bill went through.

In re-examination, Mr. TYLDESLEY JONES brought out the fact that the Power Company still had authority to supply, and that therefore there would be competition for public lighting.

In answer to the CHAIRMAN, witness said that five out of the twenty-four members of the Corporation held shares in the Gas or Electric Supply Companies. They were thus debarred from voting on matters affecting the Bill.

Mr. *T. T. Denne*, a member of the Walmer Urban District Council, and a builder, said he was strongly in favour of the introduction of electricity. It was for this reason that he subscribed to the Sandgate, Deal, and Walmer Electric Supply Company. He had since sold his shares in order to be able to vote in the Council. He did not believe the Walmer Council would ever give a supply.

In cross-examination, witness agreed that there would be no demand for electricity in the districts outside Deal and Walmer. The Sandgate, Deal, and Walmer Electricity Company had spent about £600. Although the Gas Company were to pay £1100 to the Electric Company, this would not repay them for the work which had been put into the undertaking. In answer to Mr. Morse, witness said the South-East Kent Power Company had quoted too high a price for electricity in bulk to be supplied to the Sandgate, Deal, and Walmer Electricity Company; but there had been no negotiations between the Walmer Council and the Power Company for a bulk supply.

Mr. *William Cash* handed in tables showing the financial position of the Gas Company as set out in the opening statement by Mr. Honoratus Lloyd. In 1913, there was a drop in the net revenue of the Company, due to the increased price of coal and the reduced residuals returns. Another item in the cost of gas to the consumer was the 2·13d. per 1000 feet represented by coal-dues paid to the Walmer Council. The charge for repairs and maintenance in this case was 5·55d., 5·84d., and 5·71d. during the past three years, including stoves. These figures could be taken as normal. Under the Bill the amount to be carried forward was limited to one year's dividend. Reference was also made to the amount of gas unaccounted for. Witness expressed the opinion that 10 per cent., which was the figure, was quite high enough. Dealing with gas companies owning electricity works, witness referred to the Bognor Gas Company, which received powers two years ago, when the *bona fides* of the Gas Company were doubted. The Company, however, had now a generating station at work; and the conditions were very similar to those in the present Bill. Another case was the Herne Bay Gas Company, who took over an Order from the Council by request of the latter. They had already laid some of the mains. The point urged in both these cases was that the introduction of electricity in seaside towns was an additional attraction.

In answer to the CHAIRMAN, witness said there would probably be a loss on the electrical undertaking in the first few years. The gas shareholders could have no complaint, because they sanctioned the promotion of the Bill. The Chairman desired to find out whether there was a case of a loss on an electricity undertaking falling upon the gas consumers.

Mr. BEVERIDGE, for the Deal Corporation, suggested bad management of the Gas Company, and asked if witness would wish the Committee to place electrical powers in the hands of a badly-managed gas company. Witness said it was a question of degree, and there would be no harm if the Gas Company were improving their management. Dealing with the sale of gas per ton of coal, witness said it was a usual thing for companies of this size to have a sale of 10,500 cubic feet. Without knowing the coal used, he agreed that the figure here was small.

The CHAIRMAN asked if witness thought it wise that the Company should have experimented with Kent coal even at the expense of lower results.

Witness said that this was quite the right thing to have done. Any bad results must not be used as evidence of bad management.

Mr. BEVERIDGE next dealt with the question of whether there had been any cases in which electrical powers had been granted to gas companies against the wish of the local authority. Witness said he believed Andover was the only instance. But Counsel said that Sidmouth was the only one he knew of.

Mr. RAIKES, in his cross-examination, put it that the Company had a very large reserve fund, and also had carried forward for many years very large sums. Witness agreed that this might have gone towards reducing the price of gas. On the other hand, it could have been used to pay back-dividends. Moreover, the Company were now faced with a large expenditure on renewals, for which the reserve would be useful. There was a difference of opinion as to whether, under the Gas-Works Clauses Act, a gas company had the right to carry forward. He referred to the more recent limitation of the carry forward to one year's dividends as pointing to the fact that a carry forward was allowed, otherwise there was no need to limit it. Counsel suggested that the funds in hand would justify a considerable reduction in the price of gas immediately, and mentioned a figure of 1s. per 1000 feet; but this was not accepted. A standard price of 2s. 9d. was then put to witness as the proper one, under all the circumstances. But the reply was that this must be considered in conjunction with the engineering evidence. It would not be justified, having regard to the figures in the balance-sheet, in view of the large expenditure on works in the way of renewals.

Witness, in re-examination, said that the 3s. 3d. charged last year only just enabled the Company to pay the outgoings and the maximum dividend. Therefore this seemed to be a fair standard price.

Mr. *W. H. Patchell*, late Engineer-in-Chief of the Charing Cross, West End, and City Electricity Supply Company, said he had visited the district and had come to the conclusion that the Gas Company would be in a better position to give a supply of electricity than a separate electric supply company, because the district was a relatively small one. In this he believed was wrapped-up the secret of the non-success of the previous attempts to give a supply of electricity. From the electrical point of view, neither Deal nor Walmer could possibly be a profitable proposition for separate electrical undertakings. He did not agree, however, that the existing gas area outside the two towns should be excluded from the electrical powers, because there were a number of houses just over the border which would undoubtedly require electricity, and the district generally was developing. A combined gas and electricity undertaking had facilities for

raising capital which a separate undertaking could not possibly have. The private electrical installations now in the district used about 2 million feet of gas per annum for driving their electrical plant. These had a capacity of 75,000 Board of Trade units per annum. Taking only the low price of 3d. per unit as the selling price, this represented a figure of £900; whereas the 2 million feet of gas at 3s. 3d. per 1000 cubic feet would only cost £325. This illustrated the extra expense which the users of electricity were being put to, and demonstrated that the Gas Company, by using the gas themselves and supplying from a central station, could do it much cheaper. He believed these private installations would be shut-down, as had been done all over the country, if a public supply were given. Again, the generation of electricity at the gas-works would tend to economies; for it would enable the Company to use electrical driving, which was now quite a common feature of all the large gas-works in this country. He failed to see that there would be any disadvantage in the two undertakings being in the same hands. Experience had shown that, where this had been allowed, the sales of gas increased as well as the development of the electricity undertaking. The total capital expenditure required by the Company for electricity purposes, he estimated, would be £34,000—£16,000 for the generating station, and £18,000 for mains. But at first it would only be necessary to spend £13,000—£5700 for the generating station, and £7300 for mains. This first instalment of the plant would enable the Company to supply 11,500 thirty-watt lamps. Assuming 6 units per lamp per annum, and an average price of 5d. per unit, the revenue would be £1430. The estimated total costs at 3·38d. per unit amounted to £970, leaving a gross profit of £460, which would provide 3·6 per cent. interest on the capital expenditure. From this, however, would have to be deducted depreciation and reserve; so that he did not anticipate in the first year or two the undertaking would be self-supporting. When the whole capital expenditure was in use, the number of lamps supplied, he estimated, would be 64,000. Taking 10 units per lamp, the estimated revenue would be £9340; and the total costs, at 1·07d. per unit, would give an expenditure of £2860—a gross profit of £6480, or 19 per cent. on the capital outlay.

Mr. TALBOT, for the Deal Corporation, severely criticized the estimates of witnesses, and suggested that no electrical company paid anything like 19 per cent. Witness agreed, and suggested that 9 per cent. of the 19 per cent. should go towards depreciation and reserve. Even then Counsel held that the best electric light companies in London did not pay more than 10 per cent. It was therefore a very optimistic view to suggest that a small undertaking like this would pay that amount. Clearly a loss was going to fall on the gas consumers.

Mr. JEEVES, for the Eastry Rural District Council, suggested that the electricity customers would of necessity come from the gas consumers, and so reduce the sales of gas; but the reply was that experience had shown this not to be the case. Neither would witness agree that the Deal and Walmer districts were saturated from the gas point of view, and that therefore the gas undertaking must suffer.

Thursday, April 2.

When the proceedings were resumed this morning,

The cross-examination of witness was continued by Mr. RAIKES, who dealt with the point that there would be no day load for electricity supply, and that consequently the figures of the witness could not be substantiated. In spite of the smallness of the area and the absence of day load, Counsel pointed out that the estimated financial return was larger than in almost any other district. Witness said the figures were on the basis of the plant being fully loaded, which was not always attainable. As to other larger undertakings paying lower dividends, many of them were considerably over-capitalized.

Mr. MORSE, for the South-East Kent Power Company, pointed out that witness's figures did not include anything for land, and that any estimates were not complete without it. Counsel further suggested that nothing was debited to the electricity estimates for parliamentary expenses, nor for the £1100 to be paid to the Sandgate, Deal, and Walmer Electricity Supply Company. It was agreed between witness and Counsel that parliamentary expenses might be £1000 and land £500—making, with the £1100, £2600 to be added to the £34,000 capital expenditure suggested. This would reduce the return from 3·6 per cent. to 3 per cent. on the first instalment of the capital expenditure. It was next put to witness that the units per head of population taken in this case was much in excess of a large number of similar seaside towns. The figures here were 37·5 units per head; whereas the average figure of other towns at work was 15·4 units. Witness, however, said there were other towns where the consumption more nearly approximated to the number assumed in the present case. Against this Counsel said that the average of all seaside towns with a population of under 30,000 was 23 units per head. Witness said the average price must also be taken into account in discussing this question. The average of the towns he had looked into was 18 to 20 units. To this Counsel replied that the whole of the estimated profit of 3·6 per cent. would then go.

In re-examination, Mr. TYLDESLEY JONES said that the figure of 37·5 units per head of population was arrived at by dividing the present population into the number of units which the witness estimated would be sold many years hence, when the undertaking was fully developed. As a matter of fact, the estimated consumption at the end of two years was only 4 units per head of the population. As to the commercial prospects of the undertaking, nothing had been taken for street lighting; and if there were to be any public lighting, this would be so much to the good.

Mr. *P. Griffith* said the siding proposed in the Bill would be a great economy to the Company. This, however, was not opposed. As to the gas-works, certain alterations were required, particularly the carbonizing plant, which was out of date. The result of modernizing this plant and constructing the railway would be a net economy of 2½d. per 1000 cubic feet of gas sold, after allowing for capital charges. In arriving at this figure he had assumed some saving by using Kent coal, which was now at a low price. This, however, was rather speculative, because at present the coal was on its trial for gas-making purposes. Various results had been obtained on several works under different conditions; and at present there was no standard available. The effect of this was that the value of the coal to-day was much less than imported coal. But as soon as it was proved that the Kent coal gave results equal or similar to other coal, then its price would assume a normal market value. For this reason he agreed that the economy he had assumed was an over-estimate rather than an under-estimate. He also calculated that new capital powers of £5400 would be sufficient to carry on the gas undertaking for a period of fifteen years. The standard price of 3s. 3d. was a fair one, as in a list of towns where the gas supply was between 60 and 200 million cubic feet output, there were only two (Gravesend and Sutton) where the price was below 3s. 3d.

In cross-examination by Mr. TALBOT, witness agreed that the figures per ton of coal carbonized were bad. It was for this reason that he recommended the alteration of the carbonizing plant the first time he saw the works. He would not, however, agree that there were traces of bad management, as this could not be said of a Company that had paid maximum dividends, had a large reserve fund, a large carry forward, and charged a price normal to the size of the town. Questions as to make of gas at Hythe, with which Company witness is connected, were then put. There, a mixture of Yorkshire and Kent coal was used, and the make per ton of coal carbonized was 12,267 cubic feet. At Deal and Walmer recently some very high figures had been reached. A high make, however, did not necessarily mean a proportional advantage to the undertaking as a whole. Nevertheless, he had estimated on 11,000 cubic feet when he got the new plant at work; horizontal retorts being contemplated. With regard to the additional lands, questions were put in order to show that none were needed immediately; but witness did not agree. Further retort capacity was required at once, and a coal-store and additional holder capacity were also necessary.

Answering Mr. JEEVES, for the Eastry Rural District Council, witness said that a considerable development of the collieries in the area was anticipated. It was in order to deal with this that the Company asked for the powers in the Bill.

Mr. *A. E. Brooks*, the Engineer and Manager of the Ascot District Gas and Electricity Company, who obtained electricity powers in 1906 and were the first gas company to give a supply of electricity, was the last witness for the Company. Since the supply was commenced, all the private electrical installations, with the exception of two, had been scrapped. In spite of the demand for electricity, the gas supply was also increasing. In addition to this, management expenses had decreased from 5d. per 1000 cubic feet in 1912 to 4d. in 1913. Over one-third of the gas consumers also used electricity; and, further, the price of gas had been reduced. It had undoubtedly been the experience at Ascot that the combination of the two undertakings had been for the general good.

Some interest attached to witness's evidence and cross-examination, inasmuch as Sir Harry Samuel, the Chairman of the Committee, is supplied by the Company.

Mr. TALBOT was putting questions to show that whereas the Ascot Company was a well-managed concern, the Deal and Walmer Company was not.

The CHAIRMAN remarked: You may take the answer from me. It is very well managed. There are no complaints except price.

Mr. TALBOT suggested that as the output at Ascot was 68,700 units, and the population half that of the Deal and Walmer Company's district, it followed that the possible output in the latter area would be about 130,000 units; whereas 640,000 units had been assumed. It was pointed out, however, that this figure was for the undertaking when complete—or, say, in eight or nine years' time. Witness also contended that Deal and Walmer would be a better district for electricity supply than Ascot, where the results had shown greater profits and less working expenses since the two undertakings were run by the Gas Company.

In reply to the CHAIRMAN, witness said they kept separate accounts.

Mr. TYLDESLEY JONES remarked that the Company had a clause to this effect in the Bill.

This closed the case for the promoters.

Mr. TALBOT then addressed the Committee on behalf of the Deal Corporation; treating first of the electrical proposals. He agreed that there were several cases in which electricity powers had been granted to gas companies—some in which they had been refused and a few in which the powers had been granted against the wish of the local authority.

The CHAIRMAN: I should very much like you to tell the Committee whether this is really and truly a determined opposition against us, under any circumstances, granting the preamble of the Bill, or whether it is a question that you think the terms offered you are not sufficiently good for you to accept.

Mr. TALBOT said he asked the Committee to reject the electricity powers and the land clauses, and to reduce the standard price of gas to 2s. 9d. To this he had an out-and-out opposition; it was not a question of compromise. He contended that *primâ facie* a gas company should not have electrical powers, because it was in the interests of the public that there should be competition between gas and electricity. Nobody could doubt that competition was good, and had had a most beneficial effect on the gas industry. Therefore, it would be a lamentable thing to allow gas or electricity companies to have a monopoly of both services. Any loss on the electricity undertaking must fall on the gas consumers. In this particular case, it was monstrous that the Gas Company should pay £1100 for the powers of the Sandwich, Deal, and Walmer Electricity Company, which were worthless, and which nobody else would take over. Furthermore, the Gas Company had no power to pay this £1100. Again, the Company had received no expert advice with regard to the electricity scheme before the Bill was deposited; and clearly the Directors had not gone into it at all. Mr. Patchell was only called in after the proposal had been put before the Board by Mr. Hind, and accepted. The passing of the Bill would give an absolute monopoly for both electricity and gas for all time, and the ratepayers would be deprived of the advantages of competition.

Mr. HONORATUS LLOYD: There is the Electric Power Company to compete.

Mr. TALBOT replied that if the Gas Company had thought the Power Company's competition was worth anything they would not have gone into the matter at all. Quite apart from this aspect of the question, the record of the gas undertaking as such was a bad one. A very unsatisfactory state of things had existed for a long time. The explanation was that the Company had been able to pay maximum dividends and set aside good reserve funds; and so the interests of the consumer were not considered in relation to efforts to reduce the price of gas. Such a company was the very last to entrust with electricity powers. As to the sliding-scale, his witnesses would show that 2s. 9d. was the right figure at which the Company could supply to-day, if it were properly managed. As to the new gas lands, he submitted there was no evidence of the need for these. The Company had plenty of land for storage purposes, and no case had been made for the taking of new land for manufacturing purposes, beyond the statement that the Company expected to make a certain development during the next fifteen years. The Corporation had the strongest possible objection to any increase in the make of gas on the present lands; there having been complaints.

Mr. HONORATUS LLOYD: With regard to the power gas clause, I will not ask the Committee to grant this.

Mr. TALBOT said in that event he had only one more point to deal with. That was with regard to the charge for slot-meter consumers without fittings. The Model Clause in the Bill stated that the extra charge should be 6d. per 1000 cubic feet, or 10 per cent. on the cost of the meter, whichever was the higher. This, he could not help thinking, was an inadvertence on the part of the draughtsman, as in the case of a large consumption—say, 50,000 cubic feet per annum—the charge for the meter would be extremely high. He suggested, therefore, that the charge should be 10 per cent. on the cost of the meter, or 6d. per 1000 cubic feet, extra, whichever was the lower.

Mr. *E. H. Stevenson* said that electricity supply in Deal and Walmer could not be a profitable concern, having regard to the extremely slow rate at which the gas undertaking was progressing. The rate of increase during recent years was only 1¾ per cent. He knew of only one case in which Parliament had granted electricity powers to a gas company against the wishes of the local authority. That was the Sidmouth case. But then the parties agreed for the local authority to purchase both the electricity undertaking and the gas undertaking of the Company. It was a better district than Deal and Walmer; and the promoters brought up a number of people who stated that they would like electricity. There was, moreover, not the gross mismanagement in that case which the Deal and Walmer Company had been guilty of. He had known of Unopposed Bills Committees declining to grant electricity powers to gas companies without the special consent of the local authority being produced. In this case, if the Company had gone to the Board of Trade for a Provisional Order, as they had powers to do under their Gas Provisional Order some years ago, the consent of the local authorities would have had to be obtained. With regard to the prepayment meter difficulty, this arose chiefly in the case of shilling slot meters; whereas the Model Bill was really drawn for penny-in-the-slot meters. The extra gas lands were quite unnecessary. The existing gas-works were sufficient to deal with 750,000 cubic feet per day; and the gasholders had a storage capacity of 600,000 cubic feet. There were few gas companies of this size who had a larger storage capacity, because there was now a big day-load on gas-works owing to so many cookers and stoves being in use. The 750,000 cubic feet capacity of the works represented 50 per cent. more than the present actual output. As he saw no likelihood whatever of an alteration in the rate of improvement in the near future, it seemed to him that the present works and land would carry the Company on for another fifteen years. The gasholder capacity would carry them on at the present rate of increase for a further thirty years. No extra purifiers or scrubbing plant would be wanted; while the retorts would have a capacity of 750,000 cubic feet per day, with a 7 per cent. stand-by, if the direct-fired ones were converted into the more modern type. He agreed with the necessity for the railway siding. As to the sliding-scale, the record of the Company's bad management showed that a much lower figure than 3s. 3d. would be the normal selling price with proper management. The present bad management had been going on consistently for very many years. The evidence of this was in the small make per ton of coal carbonized, the coke sold, and the sulphate of ammonia. A make of 10,500 cubic feet of gas per ton was quite a common figure for a works of this size. The state of the retort-house itself showed how bad the management had been. He had calculated that, assuming the Company had obtained 10,500 cubic feet per ton of coal during the past ten years, they had carbonized 18,098 tons of coal more than were necessary at a cost of £26,198. This justified him in saying that the price of gas could have been 6d. per 1000 cubic feet less, and yet have enabled the payment of maximum dividends.

Mr. HONORATUS LLOYD cross-examined at considerable length. He obtained from witness the admission that, speaking generally, the price in Deal and Walmer was a moderate one. It ought, however, to have been lower, having regard to the low capital expenditure, which showed that sums had been taken from revenue in the past for capital purposes, thus depriving the consumers of any reduction in price. Although the present consumers were getting the benefit of a great deal of this capital spent out of revenue, the consumers in the past had lost by the transaction. On the question of cost, it was pointed out by Counsel that it could be reduced immediately by 2d. per 1000 cubic feet if the local authorities withdrew their duty on coal. Dealing with the proposed electricity powers, witness expressed the opinion that whoever took up this venture in Deal and Walmer would run the risk of losing money. He would not recommend the local authorities to go in for it, except as an advertisement for attracting visitors to the towns. Incidentally Counsel refered to the fact that witness had recommended the Deal Corporation to ask for a purchase clause in relation to the Gas Company's undertaking; but the Corporation had not adopted his advice. The Council in their petition suggested that they were the right authority to own the electricity supply.

The CHAIRMAN: In that case there would have been no competition. A great point has been made in this case as to the necessity of having competition between gas and electricity.

Mr. HONORATUS LLOYD, continuing his cross-examination, pointed out that there were a great many towns where both electricity and gas were in the hands of the local authority. The effect as regarded the consumer was precisely the same as if the two undertakings were in the hands of a company. Witness, however, argued that, in the case of local authorities, they were working in the interests of the ratepayers, and not in order to make profits for shareholders. As to Sidmouth, he pointed out that the local authority had not put the electricity powers into force, although they had taken them over from the Gas Company. After expressing his objection to the Gas Company extending their purifying works on lands nearer to the populous part of the town, witness was questioned as to the sliding-scale. He would not agree that it was the practice of Parliament to take the actual selling price as the standard price, and then allow a margin above it in fixing the standard price. The ordinary method was to fix a price at which a company could, under normal working conditions, pay their standard dividend. In addition to the 6d. saving on coal, there should be savings on labour amounting to ¼d. per 1000 cubic feet; while the alteration in the candle power from 15 to 14 would enable a further 1½d. saving. Therefore he thought the 2s. 9d. was a fair standard. It was put to witness that last year the Company had only just been able to pay their maximum dividend, after setting aside a comparatively small amount for renewals; but he retorted that there was enough money in the reserve fund to enable the Company to lower the price of gas and still pay their maximum dividend. He feared that if the Company obtained electricity powers they would, by reason of this large reserve fund, be able to run the electricity undertaking at a loss, keep the price of gas at its present figure, and still maintain the standard dividends.

In re-examination, witness said he did not object to the principle of an electricity undertaking being in the hands of a gas company if the company were properly managed. If a sterilization clause against bad management were put in, he was sure the Deal Corporation would be very pleased.

Tuesday, April 7.

On the resumption of the proceedings to-day,

Mr. *C. Hussey*, the Mayor of Deal, and Chairman of the Special Committee of the Corporation who dealt with the Bill, was the first witness. He referred to two meetings of the Corporation on Jan. 12 and 28 last, when resolutions to oppose the Bill were passed unanimously, except for the shareholders of the Gas Company, who did not vote.

In reply to the CHAIRMAN, witness said the Corporation objected most strongly to the Gas Company having a monopoly. He thought that electric lighting would be an improvement to the town; but the Corporation considered there was not sufficient demand at present to justify an installation. If the Committee did not approve the preamble of the Bill, the Corporation were prepared to apply at once for an Order and carry out the work.

Witness, in the course of further questions in examination-in-chief, said that it was the opinion of the Deal Corporation that there was not at present a very promising field for electricity. If a supply was to be given, however, it should be in different hands, in order to ensure competition.

In his cross-examination, Mr. HONORATUS LLOYD first dealt with the speeches of the witness in favour of electricity, and obtained the admission that it was agreed that a supply of electricity would be an advantage, with the addition that, as a separate undertaking, it could not pay. Nevertheless, said Counsel, witness had bound the Corporation to apply for an Order at once. It was then put to witness that no resolution had been passed by the Corporation that they would carry out an electrical undertaking. On the contrary, said Counsel, many members had objected to the Corporation taking up the supply of electricity. Speech after speech by various members of the Corporation to this effect were referred to by Counsel, who then asked questions as to negotiations with the East Kent Power Company for a supply. Witness hesitated to go into details, but eventually said the price was to be about 1½d. per unit. This was at 20,000 volts. He was not sure whether the Company or the Corporation would transform down. The only electrical engineer they had consulted during the negotiations was the Power Company's engineer. Subsequently witness said the question of whether the Corporation would deal with the matter depended upon the price.

The CHAIRMAN: Oh, no. You distinctly told me that you would apply for an Order at once.

Mr. HONORATUS LLOYD: And it is on this basis that you tell the Committee you will apply for an Order—without having gone into the matter at all.

Witness replied that the matter had been gone into, but no definite arrangements had been come to.

In further cross-examination, witness said he believed there would be a loss on the electricity undertaking so far as Deal was concerned. He hoped that Walmer would join with them, and thus help to reduce the loss. The ratepayers had not been told this. He agreed that the Gas Company, as large ratepayers, would have to bear a great portion of the loss. Counsel made a great point of the suggestion that the gas-works should be purchased, and referred to remarks made in the Corporation meetings, that a resolution to do so was merely an expression of opinion, and, as one member of the Corporation said, "would throw dust in the eyes of the Parliamentary Committee." With regard to the complaints against the Gas Company, witness was compelled to admit that he did not know whether the Corporation had the right to test the gas, nor whether a test had ever been made. Asked whether there had ever been any complaints, beyond the one mentioned, witness said there had been some from the Drainage Committee.

In re-examination, witness said the Corporation were quite prepared to incur a loss on the electrical undertaking in order to keep the Gas Company up to the mark. He believed the town would gain on the balance.

At the close of this evidence,

The CHAIRMAN said the Committee would like to confer, and the room was cleared. Parties were re-admitted in about ten minutes, when the Chairman asked Counsel for the Deal Corporation to proceed with his case.

Mr. *N. E. Powell*, the Deal Borough Accountant, handed in a list of the properties rated in Deal; the object being to show that the assessment of private houses generally was very small, and consequently not likely to demand a supply of electricity. As to the quality of the gas, it was very poor, and had a bad smell. The general effect was to cause a rapid deterioration of the fittings. Referring to the "costs" clause in the Bill, which enabled the Company to charge them wholly or partly out of revenue, witness said the £1100 to be paid to the Sandwich, Deal, and Walmer Electricity Company could be paid out of revenue, which he did not think was right.

In his cross-examination, Mr. HONORATUS LLOYD pointed out that the members of the Special Committee appointed to consider the Bill lived in four of thelowest-rated houses in the district—one being as low as £11 10s. Witness said this was so, and also admitted that he personally had never made any complaints to the Gas Company, although he had lived in Deal for over ten years. He further agreed that a supply of electricity in the town would be an advantage.

Mr. *Parker*, the Secretary of the Lloyd Memorial Caxton Society's Home at Deal, gave evidence against the extension of the gas lands near the Home. The Trustees, he said, were considering the question of selling out if the Bill was passed. The proposal was to bring the works within 150 feet of the Home, which he admitted was instituted after the gas-works were erected. He also complained of the poor quality of the gas.

Mr. HONORATUS LLOYD, in his cross-examination, said that the Home at one time put on a governor, and complained of bad pressure. This was altered, and then the complaint was that the bill was too much.

The case for the Walmer Council was then taken.

Dr. *Hardman*, the Clerk to the Walmer District Council, said that all the members of that body, except those connected with the Gas Company, were unanimous that the Company should not have electricity powers. If they did, there would be an absence of competition, and, further, the record of the management of the Gas Company suggested that the Directors were not the kind of persons to be entrusted with these additional powers. He was of opinion that the Walmer Council would apply for a Provisional Order if the Deal Corporation did.

Mr. HONORATUS LLOYD, in cross-examination, reminded witness that although the Walmer Council had an Order in 1904, nothing had been done, and that Dr. Hardman himself had this year told the Council that the only practicable alternative to the Gas Company was for the Council to take up the matter again. But they had not done so. Reference was made to a conference of the local authorities concerned, and that the Walmer Council could not meet the Company singly to discuss terms, on account of having already conferred with the other local authorities.

The CHAIRMAN: Would you like to come to terms with the Company now?

Witness: Personally, my answer is "No."

In further cross-examination, Mr. HONORATUS LLOYD called attention to a suggestion that the Walmer Council should pass a resolution to purchase the gas-works; the idea being merely to strengthen the hands of the Council in opposition to the Bill, and not to commit the Council to the purchase. Witness did not quite accept this view of the matter, although he did say that the Walmer Council did not think of buying the Gas Company. He did not, however, regard the resolution as a bogus one. It was eventually postponed. Counsel then referred to speeches, in which members of the Walmer Council said that the question of opposition was all a matter of terms.

Mr. ST. JOHN RAIKES, addressing the Committee on behalf of the Walmer District Council, said the Council had three main objections to the Bill. First, if a monopoly was granted the stimulus of competition would be removed; secondly, there was not sufficient demand for electricity; and, thirdly, the Directors of the Gas Company, in view of their past record, were not fitted to be trusted with further powers outside their gas business. The granting of the powers asked for in the Bill would prevent any outside company from obtaining electricity powers. It would further have the effect of tempting the Company to keep up the price of gas in order to cover up the loss on electricity, and at the same time pay the dividends which had been paid during the past few years. Only three local witnesses were called by the Company to say that there was likely to be a demand for electricity; but all of them had been at one time interested in either the Gas or the Electricity Company. The real evidence upon which the promoters relied was that of Mr. Patchell, who was sanguine enough to think that this little undertaking, handicapped by a small lighting load and the absence of a day load, was going to return a larger dividend than did any electrical undertaking in industrial areas. Surely if this was the case it would not have been so difficult to induce financiers to take up the undertaking, as had been the case in the past. He then criticized the management of the Company on the lines brought out in cross-examination, and contended that, without any alteration in the present conditions, with ordinary care, the price need not exceed 3s. 1d. per 1000 feet, and that, in consequence, the standard price should be considerably reduced. The only interest of the Council was to see that the Company should be placed upon a sound footing; and all the evidence went to show that, by proper economies and working, the reduction would be still more. Taking an average of the economies claimed on both sides, a standard price of between 2s. 7d. and 2s. 8d. was arrived at. He therefore asked for the rejection of the electricity powers, and that a reasonable standard price for gas should be fixed.

Mr. JEEVES, for the Eastry Rural District Council, said there were 21 parishes in this area. Three of them had been in the Gas Company's area for fifty years, and only three houses were supplied with gas. Under the Bill the Company merely took an enabling power to supply electricity; and if it did not do so within five years then the powers ceased. Therefore it seemed to the Council that they were not only getting nothing, but the granting of the powers to the Company would prevent them developing the supply themselves should the colliery districts extend, as was expected. He therefore asked that any electricity powers should be confined to the Company's existing gas area. The Council wished to keep the rural district free from any such wandering powers as were now proposed.

The CHAIRMAN: It may be a valuable district in the future.

Mr. JEEVES said the colliery development would not necessarily take place in the three parishes of the rural district included in the Bill; and it might be that an Electric Lighting Order would have to be applied for by the Rural District Council.

Mr. *H. Rice*, a member of the Rural District Council, gave evidence in support. At the moment there was no demand for an electricity supply, and the Council wished to be unfettered in dealing with the future development of the district.

The CHAIRMAN: How long do you think you will want to remain the authority, in the way you suggest?

Witness replied that the Rural District Council already had the powers, and did not want them taken away.

Replying to a further question by Mr. HONORATUS LLOYD, witness stated that his own house was quite close to the Power Company's generating station at Tilmanstone. Nevertheless, he used paraffin for lighting.

Mr. SYDNEY MORSE then addressed the Committee on behalf of the Power Company. He said he did not propose to call any witnesses. A case for a demand for electricity had not been made out, he contended, by the local witnesses. The main evidence in favour of the electricity proposals was that of Mr. Patchell, who, he had already shown in cross-examination, had not included many items in his capital expenditure which he ought to have done, and had adopted a figure for the number of units consumption per head of population far in excess of anything which similar seaside towns now working showed. Counsel had put the average figure at 15·4 units per head of the population, whereas Mr. Patchell had assumed something over 37. As a matter of fact, Weston-super-Mare showed less than 15. If the figures which had been put to Mr. Patchell were correct, then the whole case made out on his estimates was cut-away from under his feet. Apart from this, however, no allowance had been made for depreciation, which Mr. Patchell agreed might be £2000, nor for engineering expenses, nor for the £1100 to be paid to the Sandwich, Deal, and Walmer Electricity Company. He maintained that the revenue from the undertaking would be only one-half of that estimated by Mr. Patchell. On this basis it could not possibly be regarded as a profitable undertaking.

Mr. HONORATUS LLOYD, replying on the whole case, dealt first with that of the South-East Kent Electric Power Company, represented by Mr. Morse. He had been expecting to see the Engineer of the Company, who would have said that he had a beautiful generating station at Tilmanstone, upon which £20,000 had been spent, and that he was willing to give a supply immediately. There had, however, not been a word of evidence upon these matters. The merest tyro could have said what Mr. Morse had said about Mr. Patchell's estimates; and he seemed to have suggested that if half the quantity of electricity which was estimated was produced the revenue would be halved, but the expenses would still be as much, and that the same amount of coal would be used as for the larger output. This was a very obvious fallacy, and would have been patent to a child. There was, however, a far more important matter than this for the Committee to deal with. It was common ground between everybody concerned in the district that it was one which should be supplied by electricity, and that it was actually desired; and the rest of the case, to his mind, conclusively proved that it was a district which should be supplied by the Gas Company. *Primâ facie* he agreed that electric light and gas should be in two different hands. In all cases until quite recently the two undertakings had been entrusted by Parliament to different people; and he was inclined to think that it was a pity it had not been universally adopted. Then, however, the local authorities came on the scene, and in very many cases were controlling the electric light and gas undertakings to the satisfaction of the ratepayers and the consumers alike. And recently Parliament had come to the conclusion that, in special districts where electricity was required and could not be supplied at a remunerative rate by an independent company, the gas companies should be allowed to do it. He put the present case forward as a special one, and did not contend that in all cases it should be done. The argument that financiers had not been found to take up the proposal in the past, was in his favour rather than otherwise, because it was obvious that no large financial house would take up a comparatively small undertaking only needing £30,000 of capital. That there was a demand, and that the district needed it, seemed now to be common ground. The real fear in the minds of the local authorities was that the Gas Company would hold-up the powers merely to push their gas undertaking, and at the same time keep out competition from the electric light. If the Committee came to this conclusion, then he would ask them at once to throw out the Bill. But it was not the case. As the Bill was drafted, there were certain provisions in it which, while common to previous Acts of the same sort granted to gas companies, were not in agreement with the ordinary law applying to electric lighting companies. He had, however, advised his clients to come under the ordinary law, with the result that the clause compelling the Company, under penalties, to give a supply within two years in the compulsory area had been inserted. The whole of the facts showed that this was one of those cases in which gas and electricity could develop side by side in the same hands, and that the Gas Company could provide the electricity in a way that nobody else could. In these circumstances, what was there to be said against it? The Company had offered the neutral zone, which gave the advantage of 3d. reduction in the price to the gas consumer before the shareholder participated in any profits under the sliding-scale; so that there was every inducement to the Company to run both undertakings economically and profitably in order to bring down the price of gas, and so increase their dividends. Then it had been said that the Company were badly managed; but what was the evidence upon this point? It was first said that the Company had too much money in reserve, that they carried forward too much each year,

and that they had not scrapped the retort-house and gas-making plant as soon as they might have done. It seemed a little hard to allege as bad management that the Company had not scrapped their plant soon enough, and then to say that they had made too much money. As a matter of fact, the reserve fund was not larger than Parliament allowed, although the carry-forward was more than Parliament permitted in more recent legislation when dealing with the sliding-scale. The policy of the Company had been to do more work out of revenue than they need have done, with the result that they had a very low capital expenditure, of which the present consumers were getting the benefit. While in the petitions the local authorities alleged that the price was high, Mr. Stevenson, the expert called for the Deal Corporation, had admitted that it was a moderate one, and therefore not only had the Company not been badly managed, but the results which they had obtained were highly creditable. The suggestion by Mr. Stevenson that the price could be immediately reduced by 6d. per 1000 cubic feet was sufficient on the face of it to condemn itself. Finally, some reference had been made to the insertion of a non-enhancement or sterilization clause in the Bill. Apparently the Company were going to embark on a thing which it was said would be disastrous, and yet at the same time would enhance the value of the undertaking. How these two things could be compatible he did not know. He would, however, remind the Committee that a sterilization clause was never put into a Bill, and that there was no object in putting one in, unless the Councils were going to buy the undertaking.

The room having been cleared,

The CHAIRMAN, on the re-admission of the parties, said that the Committee had decided, although not unanimously, that the preamble was proved, subject to certain alterations. The first was that the Committee considered the sum of £1100, to be paid to the Sandwich, Deal, and Walmer Electricity Supply Company, quite excessive, and suggested that £500 would amply meet the case. Then the Committee were strongly of opinion that if the local authorities were really serious with regard to the electricity supply, they should have the option of purchasing the electrical powers within one year. Finally, the Committee were of the opinion that the part of the Company's gas area outside Deal and Walmer, represented by Mr. Jeeves, should be excluded from the electricity powers. It depended entirely with the promoters whether they were prepared to accept the preamble on these terms. If they were, it would be for them to bring up clauses.

Mr. HONORATUS LLOYD asked if the Chairman would make it a little more clear what he meant with regard to the electricity powers.

The CHAIRMAN said the Committee felt they must safeguard the interests of the corporate bodies. They frankly doubted whether the local authorities intended to purchase; but it was felt that, if they were really in earnest, they should have the option of promoting a Bill next session to purchase the electrical powers, whatever the price might be.

Mr. HONORATUS LLOYD: You mean with regard to the electric lighting undertaking and not the gas undertaking?

The CHAIRMAN: Not necessarily the gas undertaking.

Mr. BEVERIDGE, for the Deal Corporation, asked whether the standard price, as suggested by the promoters, would stand.

The CHAIRMAN: Yes.

Mr. HONORATUS LLOYD asked whether the Committee had considered the question of the time limit. If they gave the local authorities a year to make up their minds whether they would purchase the electrical powers, it put the Company rather in a difficulty with regard to the two years compulsory period. It was true the Gas Company could start at once with the electrical works.

The CHAIRMAN said the Committee were of opinion that the Gas Company would be refunded everything spent.

Mr. HONORATUS LLOYD: I think we can get over that difficulty.

The Committee then adjourned, and the clauses will be submitted next Tuesday.

Competition Wanted.

The Waltham Cross, Cheshunt, and District Traders Association recently discussed the question of introducing electric light into the district. Mr. A. Coles (the Chairman) said that members of the Committee of the Association had had an interview with representatives of the North Metropolitan Electric Supply Company, who were prepared, upon being satisfied that there would be a sufficient demand, to make provision for a supply of current. They wanted to be assured of £2000 worth of business per annum before they laid the cables. Mr. J. B. Franklin (Vice-Chairman) said they knew of fifty signatures, representing a total value of £700 worth of light per annum. He maintained that if the district were properly canvassed there would be no difficulty in getting quite £3000 worth of business. They had had enough of the monopoly of the local Gas Company, who had "done themselves well." If they had competition in lighting, the price of gas would go down immediately. Another speaker said that they had awakened the Gas Company sufficiently to make them introduce high-pressure lighting; but this was not altogether what they wanted. Traders had opposition; and the Gas Company ought to have something of the sort. They were paying 3s. 2d. per 1000 cubic feet, whereas at Tottenham, where the Gas Company had opposition, the price was 2s. The following motion was carried unanimously: "That this meeting of traders of Waltham Cross, Cheshunt, and District, having recognized the inefficiency of artificial light in the district, pledges itself to give the Committee of the Association its utmost support by helping to introduce electric light into the district."

Electrical Losses at Redditch.—The Redditch Urban District Council have been informed by Mr. W. Bladon, one of their members, that a careful examination of the accounts showed that the loss upon the electricity undertaking for the year ended March 31, 1913, was about £3351. In the year just ended the loss appeared as £3089. This showed an "improvement" in the general position of the undertaking. He thought the ratepayers might look for better times in connection with the undertaking.

LEGAL INTELLIGENCE.

ELECTRICITY CHARGES AT LONG EATON.

HIGH COURT OF JUSTICE—CHANCERY DIVISION.

Monday, April 6.

(*Before Mr. Justice* SARGANT.)

On the resumption of the hearing this morning,

Mr. *W. E. Radford* was called for the plaintiffs, and examined by Mr. ROMER. He said he was a lace manufacturer carrying on business at Long Eaton. His factory was what was known as a "shed" factory—*i.e.*, a factory of one storey. He employed electric power, and originally desired to use gas for lighting. He, however, received notice from the Council that, unless he took electricity for lighting, he would have to pay more for his power. He had purchased gas for another factory before he received the notice. In consequence of the circular, he made a change in his arrangement. He had a lot of gas-fittings; but after receiving the circular he took the electric light. His factory was at times working for the whole 24 hours; but the usual hours were from 4 a.m. until midnight. Sometimes his machines stood idle, and he would then use the electricity for light alone. There were frequent occasions when he employed the current for light, when he was not using it for power.

Cross-examined by Mr. MARTELLI, witness said that for the winding machinery he employed women and girls; and their hours were limited by the Factory Acts. The hours this machinery would be working were from 7 a.m. to 7 p.m. There was no night shift. He could not say what proportion of the load was on the winding machinery, and what on the other part. The load on the other machinery would go on to midnight, the time when the electric light would be used. His was a new factory. He had had no previous experience of the electric light, though he had of gas.

Re-examined: He should think that he used about one-tenth of the energy for lighting that he did for power.

Mr. *George Stevenson*, Manager and Secretary of the Long Eaton Gas Company, said their area of supply included Long Eaton, while that of the defendants was confined to it. The Council were, however, applying for power to extend their area. In some of the factories at Long Eaton the landlord supplied the tenants with power, which was generally steam. The shed factories were a more modern type, and the old style were going out. They usually were supplied with electric power. There were four types—those that took electricity for power and gas for light, those that took electricity for both power and light, those that took steam for power and gas for light, and those that took steam for power and electricity for light. The general principles of charging were the same with both gas companies and electricity companies. Generally speaking, light would not be wanted by the factories when they did not require power.

Cross-examined: He had been a member of the District Council, but resigned when the present action was brought. He did not think there were advantages in using electricity instead of gas. He did not agree that it was cleaner, or that the insurance premiums were higher where gas was used; and he thought gas was better for both light and power, as it was more under control. The Council were rivals of his, and it was open competition. He did not think that the bulk of the new factories were taking electricity both for power and light. He did not agree that the use of electricity for both light and power must tend to uniformity of the load.

Mr. *Harold B. Sketchley*, a lace manufacturer of Nottingham, said his factory at Long Eaton was erected in 1904. In consideration of his taking electric energy for light, the Council cancelled their increased charge for power. There were separate meters for light and power. He would not be using the light when the power was not being taken. It would be very exceptional if he did. In 1912 he was enlarging his factory, and he asked the Council to allow him the reduction from that time; and he had it as from the commencement of 1912.

Mr. PERCY WHEELER summed up the case for the plaintiffs, which was then concluded.

The Defendants' Case.

Mr. MARTELLI, in opening the case for the defendants, said it had an importance beyond that which applied to the present parties, for it was a common practice now for suppliers of electricity to charge one rate where the energy was taken for power only, and another where both power and light were concerned. As he understood, the sole question which his Lordship had to decide was whether what the Long Eaton District Council were doing or proposing to do was an infringement of sections 19 and 20 of the Electric Lighting Act of 1882. Unless restrained by the powers given them by Statute, the Council were entitled, like any other traders, to sell their goods to whomsoever they chose, to the best advantage to themselves. No doubt there was an analogy between the question in the present case and railway rates, to which the majority of the authorities cited referred; but it must not be carried too far. In the case of railway rates, the Courts were considering the charge for the carriage of goods; but here the Court was considering the charge for supplying goods. As he understood it, the questions his Lordship had to decide were three: First of all, under section 19, did the customers for power get their supply under similar conditions as those who had it for both power and light? for the words of the section were that it was customers who were taking a supply "under similar circumstances" that were entitled to a corresponding supply. The first question, therefore, was were customers for light and power customers taking a supply "under similar circumstances"? The next question was: Did the former—that was to say, the people who used the current for both power and light—get a corresponding supply to those who used it for power only? The third question was whether there was any undue preference under section 20. The defendants asked his Lordship to answer all these questions in the negative.

Mr. Justice SARGANT: Is your contention that, taking the two first questions, in order that the plaintiffs may succeed I shall have to answer both of them in the affirmative—that one will not do?

Mr. MARTELLI said this was so. He proposed to deal with the case first of all on the assumption of there being no question of partial lighting.

Mr. Justice SARGANT: If it is bad as to part, it must be bad as to all the rest.

Mr. MARTELLI acquiesced. With regard to the first question, he said it was important to remember that all the factories in Long Eaton were worked under normal conditions. They were practically in operation 20 hours out of the 24.

Mr. Justice SARGANT said he thought this was the evidence given by the plaintiffs' witnesses.

Mr. MARTELLI said one further point was that when they were not running up to their full normal time they would work in the day in preference to the night. The evidence was that 20 per cent. of the winding-machine work was done by women, who could only be employed in the factory for 12 hours; and these were the daylight hours, which were practically from 7 a.m. to 7 p.m. At 7 p.m. a substantial part—defendants thought 25 per cent. at least—of the power was shut off. Where, therefore, the energy was taken for power only at 7 p.m , 25 per cent. of the generating plant would become idle, and would remain so until 7 o'clock the next morning. Therefore a man who used the current for power only was a much worse customer than the one who used the current for both light and power. Assuming that a quarter of the machinery taking the power was shut down at 7 p.m., it would be to the benefit of the Council to have a larger lighting load, so as to equalize the day load, for they could have a quarter of the load that had been required during the day not needed at night. The figures showed that the day load was seven-tenths of the total load; and it must be an advantage to compensate for the maximum of the day load by getting users of the current for lighting purposes at night. The maximum power load was always during the day. The Council had to consider who were their best customers, and get these customers to take the power at night, which would at least be some compensation for the machinery intended to supply the maximum load demanded. Everyone, therefore, who took current for light must be a better customer than one who did not. If his Lordship came to the conclusion that one customer was better than another, the preference was justified. It must also be borne in mind that light was four times the price of power. Electricity for power was ¾d. per unit, while that for light was 3d. He did not suggest that the principle he was contending for would apply when something besides electricity was supplied. For instance, the Council could not make a difference in their price for electricity to a consumer because he took coke from them; but he certainly did submit that they were entitled to differentiate in their charges for electricity between what he might call a good and a bad customer.

The following evidence was called in support of defendants' case.

Mr. *John Francis Snell*, examined by Mr. COURTHOPE MUNROE, said he was a member of the Institution of Electric Engineers, and had had considerable experience, extending over 26 or 27 years, with electrical undertakings. He was familiar with the Electric Lighting Acts. He had had before him the Board of Trade accounts in connection with the Long Eaton District Council, and had also made himself acquainted with the accounts of some of the consumers. He had in this way ascertained the load factor of the station and that of some of the consumers. The former was 26·01 for the year ending March, 1913. The load factor was an important point, because that of the consumer determined the load factor at the station. A consumer having caused the undertaking to put up plant capable of producing a certain load, the more current the consumer took out of the load the better it was for the undertakers, as the cost per unit of production would be less. The better the load factor, the cheaper the rate at which the undertaker could afford to sell, because of the lower cost to him. Another factor was what was known as the "diversity load." A supply company had to provide for a maximum load. In the case of the defendants, it was 950 kilowatts, which was the capacity of the plant installed, whereas 658 kilowatts was the maximum required; giving a margin of about 300 kilowatts. The maximum that could have been required was 858 kilowatts, whereas the actual maximum was 658. The increase in the demand for the electric light would tend to improve the diversity table. For this reason a consumer taking a supply of energy for power only, and one taking it for power *plus* light, could not be said to be having a supply under similar circumstances; the load factor would not be the same. There might, however, be cases where the load factor of the person taking energy for power only would be better than that of one taking it for power *plus* light. But as a rule it would be the contrary. At Long Eaton the consumer of energy for power *plus* light would have a slightly better load factor than the consumer for power only; and, speaking generally, he was the better consumer from the Council's point of view.

Mr. COURTHOPE MUNROE asked witness if he had made out a table showing the averages of energy taken by, and price charged to, certain consumers.

Witness said he had prepared a sheet with a list of the averages. Taking two consumers who paid the Council practically the same amount—viz., £190 a year—one of them, "A," had a 20-kilowatt motor and a 6-kilowatt lighting installation. The units registered were 47,544 for power and 3352 for lighting—a total of 50,896. The lighting was charged for at 3d. and the power at ¾d. per unit; the average being 0·898d. Taking another case, which he would call "D," the consumer was paying practically the same as the other—£190 6s. 4d. "D" had an 18-kilowatt motor, and had installed 8·2-kilowatt plant for lighting. The units registered in this case were 37,836 for power and 28,740 for lighting, or a total of 66,576. The lighting charge in this case was 3·707d. instead of 3d. per unit, because 3000 units came within another scale. The power charge worked out at 0·798d.—rather more than ¾d. The average charge per unit was 1·045d. in the case of "D," against 0·898d. in the case of the other consumer. Therefore this was a case of both taking light and power, both paying the Council about £190 a year, but one paying 0·898d. and the other 1·045d. per unit. He justified this by variance in the quantity taken and variance of the average supply.

Mr. Justice SARGANT: And in both cases they were taking power and light.

Witness said this was so. It was merely to show that with consumers of both power and light the prices varied with the quantity of energy taken. In the case of consumers who used power only, one took 30,190 units, for which £125 18s. 10d. was paid, and another 34,276 units, and got it for £142 16s. 4d.—one paying ¾d. and the other a price averaging 0·936d. per unit. The variation in charge was justified by the quantity of energy taken.

In cross-examination by Mr. ROMER, witness said he did not contend that the cost per unit for supplying power in Long Eaton was greater than that of supplying light. In some cases he agreed that, from his figures, it would appear that the Council would get more from the consumer to whom they supplied power only than they would from one to whom they supplied both power and light. He could not say that the cost of supplying power was greater than the cost of supplying light. Asked, if this was so, how he accounted for the fact that 3d. per unit was charged for light, and only ¾d. per unit for power, he said it was because of the difference in the continuity of the quantity taken. He had not shown any case where a consumer's load factor was increased by his taking current for light as well as power, If all the factories in Long Eaton took current for light, the Council could not supply it without increasing their machinery.

Mr. *Frank Worrall*, the Engineer to the Long Eaton Urban District Council, said he had had charge of their electricity works since 1900, when the Provisional Order was obtained. The supply was actually started in 1903, and had been successful. They had expended £35,000 on the undertaking, and had applied £600 in reduction of the rates. They were now contemplating a further capital outlay. They had from time to time lowered the price charged for current. Long Eaton was purely a manufacturing district. Before electricity was introduced, the motive power for the factories was either steam or gas. They had had one instance of a factory lighted partly by gas and partly by electricity, and the consumer was given the benefit of the reduction. This was the only case of the kind they had had; and he thought it extremely unlikely that they would have another. They charged less for power than they did for light, because they could use the machinery for power when it was not required for lighting purposes.

Mr. *William Jenkins*, the Chairman of the Urban District Council and also of the Electric Light Committee, gave reasons for making the differentiation.

Mr. COURTHOPE MUNROE, in summing up the defendants' case, submitted that, because one or two cases might work out the wrong way, the Council were not to be prevented from giving a preference which would hurt nobody and would attract to their undertaking people whose custom was beneficial. Only two persons would be hit by the scale of charges, and this would be because they had an abnormally good load.

Tuesday, April 7.

On the hearing being resumed this morning,

Mr. MARTELLI asked permission to continue the summing-up of the case for the defendants; Mr. Courthope Munroe being unavoidably absent.

Mr. Justice SARGANT said the case was one of such importance that he desired to get from Counsel all the assistance he could.

Mr. ROMER not offering any objection,

Mr. MARTELLI (continuing) said it seemed to him that the real question was what meaning was to be put upon section 19 of the Electric Lighting Act. He did not think that his Lordship's attention had been called to the exact words of the section. They referred to the supply of electricity "provided in any part of an area for private purposes." The expression "private purposes" was defined by section 3 (subsection 4). "Public purposes" meant lighting a street or public building, and "private purposes" included "any other purposes whatever to which electricity may for the time being be applicable." In considering this case, therefore, with reference to its particular facts, "private purposes" included both power and light. His submission was that what was forbidden by the section was discrimination as between two persons who took light or between two who took power; but there was nothing which forbade discrimination between consumers who took power only and those who took both power and light. Where the charge was made under two different scales—two different prices—section 19 was not contravened, because the purchaser could come under which scale he pleased. The Court must assume that the defendant Council knew their own business best, and that this proposed scale was for their advantage. The person against whom there must not be discrimination was one taking a supply under precisely the same circumstances as some other person. How could it be suggested that the supply of energy for power corresponded with a supply for both power and light? Counsel having expressed his wish to deal shortly with the authorities to which reference had been made,

Mr. Justice SARGANT said he did not desire to curtail Counsel's arguments in any way. He should be unable to give judgment during the present sittings, as the case was one of such great importance that he must consider it. He could not help thinking that the matter must be thrashed out on much more elaborate evidence than that which he had heard from either side.

Mr. MARTELLI agreed, but submitted that the defendants' evidence, so far as it went, was that there were distinct supplies—power supply, which meant any supply of energy for driving machinery, light supply for lighting, and a light *plus* power supply. His contention was that for the purposes of the Act it could not be said that persons taking different supplies were having a supply under precisely similar circumstances.

Mr. Justice SARGANT said that, on the question of fact, he supposed that the winding was a separate part of the lace business, and was carried on in a different part of the building; and therefore when the power stopped for the winding machinery the light would also be

stopped. The light in the winding department would not be required after the machinery had stopped.

Mr. MARTELLI agreed that this would be so.

Reply for the Plaintiffs.

Mr. ROMER, replying on the whole case, said he should assume that to the defendants the cost of energy was the same both for power and for light, for he thought the evidence proved it, or that the cost of the production of light was slightly higher than that of power.

Mr. Justice SARGANT remarked that he did not understand that any difference in price was now insisted upon. He took it that the defendants were relying upon the additional demand for light as producing a levelling-up.

Mr. ROMER said he might then start with this fact, which was not disputed—that light cost, if anything, more than power. The defendants charged 3d. per unit for light and only ¾d. per unit for power; and yet they were contending that they were endeavouring to obtain customers for light in order to cheapen the cost of production. If light cost more to produce, there must be something wrong in their deduction. The result was that, though light cost more, they were charging for it as the cheaper article. This change, he submitted, was merely to get the customers of the Gas Company to take energy for electric lighting. Of course, they were justified in doing what they could, but he contended that this method of proceeding was clearly in contravention of sections 19 and 20 of the Act of 1882. The fallacy lying at the bottom of their argument was that they could supply a man more cheaply with light and power than they could supply one man merely with light and another with power. He could understand this argument if the machinery were worked in the daytime only, because then that which supplied the light at night could be used for supplying power in the day; but immediately they had overstepping the contention failed, because they must have machinery sufficient for supplying the maximum load. When a man who was taking power asked to be also supplied with light, he was no different, so far as the cost of his supply was concerned, from one who asked to be supplied with light, and said he was not taking power. Counsel concluded by saying his submission was that this proposed distinction must be *ultra vires*.

His LORDSHIP reserved judgment until next sittings.

SECURITY FOR COSTS IN A MANTLE ACTION.

In the Court of Appeal, on Monday last week, Lords Justices Kennedy, Swinfen Eady, and Phillimore had before them an appeal by the defendants in the action of *Fabrik Elastischer Gluhkorper v. Imperial Lamp-Works* (*Brimsdown*), *Limited*, from a decision of Mr. Justice Coleridge to refuse to order the plaintiffs to give security for costs. Mr. Macnaghten said the plaintiffs were a German corporation who brought their action to recover £900, the price of incandescent gas-mantles; and, by reason of the fact that they were a foreign corporation, the defendants were entitled to security. But it was said they were not so entitled, as they had no defence to the action; so that the whole question turned upon whether the defence which had been put in was a real one. In July, 1911, an agreement was entered into by which the defendants were to have the sole right to sell the mantles manufactured by the plaintiffs; and it was agreed that the latter should recognize as legally binding upon them an agreement which defendants had made in June, 1907, for the supply of mantles to the New Elastic Mantle Company, and should fulfil the obligations the defendants had undertaken. It was further agreed that the defendants should sell, and the New Elastic Mantle Company should buy, a minimum quantity of 2 million mantles within twelve months from July 1, 1912, and that deliveries should be made monthly—the defendants guaranteeing that the mantles should be absolutely reliable. Between July, 1911, and April, 1912, plaintiffs supplied mantles to the Company, though nothing like in the quantity specified, and many of those supplied were faulty. The Company accordingly commenced an action for breach of contract, claiming damages; and defendants paid £750 in full satisfaction. This they now sought to set off against the amount claimed by the plaintiffs. The defendants had also lost their profit of 5s. 3d. per gross on 2 million mantles; and this sum they also sought to recover. His point was that he had a perfectly good statutory set-off under section 53 of the Sale of Goods Act. Without calling on Mr. Spokes for the respondents, their Lordships dismissed the appeal with costs, holding that the defence was really a counterclaim to recover money paid, and that the plaintiffs ought not to be ordered to give security.

Coke and Smoke Abatement at Warrington.—At a recent meeting of the Warrington Gas Committee, a resolution from the district branch of the Smoke Abatement League was read, asking that the Committee should consider the desirability of delivering coke in small quantities in all parts of the town at reasonable prices. It is an interesting coincidence that the resolution should be passed at this juncture; for almost simultaneously with its receipt, Mr. J. M'Nicholl, the Assistant-Engineer at the Warrington Gas Works, was being elected President of the Manchester District Junior Association; and his presidential address was devoted solely to the coke problem.

Dartmouth Gas Company.—The accounts presented at the annual meeting of this Company showed that, while the revenue had increased by £17 as compared with the previous year, the expenditure had gone up by £264. The Chairman (Mr. R. W. Prideaux) said the increase in the working charges emphasized the necessity of proceeding with the installation of regenerative settings. The coming year would be a difficult one for the Company; for as they were going to convert the coal-store into a retort-house and the present retort-house into a coal-store, they would have difficulty in the storage of coal, and would have to take smaller quantities. This would add to the already high cost of coal and freight. They hoped, however, to complete the alterations by Michaelmas, and for the last three months of the year to have the advantage of more economical working. It was decided to pay a dividend of 10s. per share.

MISCELLANEOUS NEWS.

GAS LIGHT AND COKE COMPANY'S BILL.

Without indicating the line of action it will itself take, the St. Pancras Borough Council has invited all the municipal authorities whose administrative areas are included within the scope of the parliamentary powers of the Gas Light and Coke Company to state what attitude they intend taking towards the Bill of the Company, which is to engage the attention of the House of Lords Committee on the 28th inst. The inquiry points out that the Bill proposes *inter alia* to substitute a modified standard of calorific power for the gas supplied by the Company, and also to afford relief to the Company from the obligations imposed by Parliament as to the prescribed illuminating power.

The reply forwarded by the Law and Parliamentary Committee of the Hammersmith Borough Council indicates that only passive resistance to the Bill is likely to come from that body. It states that the Committee "do not consider it conducive to the interests of the consumer that the Company should be relieved from their obligation of supplying gas of the present prescribed illuminating power, or from liability to penalties in case the gas supplied by them should be of less illuminating power than such prescribed illuminating power." The Committee further express the opinion that both the prescribed illuminating power and the calorific power should be specified. They have asked the member of Parliament for the borough (Sir William Bull) when the Bill comes before the House of Commons, to give effect to these views.

LINCOLN GAS AND ELECTRICITY PROFITS.

At the Meeting of the Lincoln City Council on Monday last week, it was recommended that, out of the current year's profits of the gas undertaking, £5500 should be placed at the disposal of the Finance Committee to be applied in relief of the rates. From the explanation afforded by Alderman Wallis, it appeared that the Gas Committee had already contributed £500 to the cost of the Westgate ground and £400 to the Boultham Baths; leaving an available balance of £6111, out of which the further payment of £5500 was recommended. To show that the expenditure would be well justified, it was mentioned that there would be £10,000 at the end of the year representing the reserve fund; while there was still £1000 to come in from the loan fund.

In seconding the proposal, Mr. P. Milner indicated that there was a feeling abroad that in the future users of gas should reap some benefit from the undertaking by a reduction in price; and this view was emphasized in the subsequent discussion. Mr. Auckland contended that no profit ought to be made, and that in this case the price charged in Lincoln might be reduced by 4d. per 1000 cubic feet. Mr. A. Taylor, who proposed that the matter should be referred back, argued that grants in aid of the rates were unfair to the gas consumer, and particularly to the working classes, who paid rates through their rent.

Alderman Wallis's submission was, however, that the price charged locally was reasonable; and the Committee's recommendations were adopted.

It appeared that the gross profits on the electricity undertaking had amounted during the year to £6431. Repayments of loan and interest had absorbed £4065, leaving a net profit of £2366. The Committee's proposal in this case also was adopted—carrying £1500 towards the reduction of rates, and £691 to the reserve fund.

TREDEGAR LOAN AND MANNESMANN TUBES.

Discussion by the Council.

The question at issue between the Local Government Board and the Tredegar Urban District Council with respect to Mannesmann steel tubes for gas-mains [see "JOURNAL" for March 10 and 17, pp. 675, 743], came up for further discussion at a meeting of the Council last Tuesday.

Mr. D. W. DAVIES (the Gas and Water Engineer), in his report, said: "Referring to the letter of the Local Government Board dated March 2, in which it is stated that 'the loans are approved on condition that no payments will be made in respect of Mannesmann steel tubes out of the amount now sanctioned for mains,' I recommend that you ask the Board to reconsider the matter, and, if necessary, allow me to interview them with a view to discussing the question. At the same time, attention should be drawn to the fact that works to which the loan applies have been so very much delayed already that further delay may prevent them being completed for next winter; and we shall consequently be seriously handicapped in meeting the demand for gas. After further perusal of the Board's last letter, it occurs to me that we can proceed with some of the works at once; and, if your Clerk agrees, I recommend that these works be commenced forthwith."

Mr. FILER said it appeared to him that the Board, when they saw the mistake they had made, "climbed down." He would like to have the matter cleared up.

The CLERK (Mr. H. J. C. Shepard) explained that at the meeting on the 3rd of last month he submitted a letter received that morning from the Board, forwarding to the Council the formal approval to the borrowing of a total sum of £9900—£6900 for a gasholder, liquor well, sump, offices, store-room, retort-bench, rotary washer, and scrubber. The amount for mains was £1326, and the balance of £3000 for meters. The letter went on as follows: "The loans are approved on condition that no payments will be made in respect to Mannesmann steel tubes out of the amount now sanctioned for mains."

Mr. NORTH: Is the objection still holding good if we use Mannesmann tubes? This is the sum and substance of the matter.

The CLERK affirmed that it was one of the conditions, as he had stated.

Mr. FILER: In the face of anything said in the Press, we cannot have Mannesmann steel tubes?

The CLERK said that if any portion of the loan was spent on Mannesmann tubes the Council would be liable to a surcharge.

Mr. NORTH: They don't give any reason why we shall not use Mannesmann tubes. The Gas and Water Engineer says that they are the best.

The VICE-CHAIRMAN: Judging by the Press, the Board have climbed down.

The CLERK pointed out that he had not written to the Board for reasons, as he was waiting to settle another matter.

Mr. NORTH: Are we to understand that the Gas Manager's opinion as to the suitability of Mannesmann tubes is the same to-day as when we accepted it?

Mr. DAVIES: It is stronger to-day—because of the action of the Board.

The Clerk was instructed to write to the Board asking for an explanation of their action.

PRIMITIVA GAS COMPANY OF BUENOS AIRES, LIMITED.

The Thirteenth Annual Meeting of this Company will be held next Friday. The Directors report that the balance of the revenue account for 1913 and the interest received from the German Transatlantic Electricity Company amount to £361,645; while the receipts from other sources were £6493. To the total of £368,138 has to be added the amount brought forward from the last account—£40,480—making a gross total of £408,618. Out of this amount £264,213 has already been paid away in the matter of debenture interest, sinking fund, depreciation, income-tax, and dividends on the ordinary and preferencee shares. From the profit and loss credit balance of £144,405, the Directors have already made the following payments: A final dividend of 4s. 6d. per share (less income-tax), making a total distribution of 8 per cent. for the year, on the ordinary shares, which will absorb £58,500; to the pension fund, £2000; to the Retiro works amortization account, £35,000; to discount on the debenture stock (1911) and expenses of issue, £5000—amounting to £100,500 in all, and leaving to be carried forward £43,905.

The Board report that, owing to the great commercial depression in Buenos Aires, a large number of houses and offices were unoccupied during the year, and there was a falling-off in the private consumption of gas. But this was more than made up by an increase in the demand for heating, cooking, and power; so that the total sales exceeded those of the previous year. The demand for coke and residuals was fully maintained, and the prices were satisfactory. The new chemical works are now finished; but were not (owing to delays by the contractors) in full working order until October last. The General Manager anticipates that substantial profits will be made by this department. The network of mains was increased during the year by over 45 miles—making a total of 1106 miles; and 7479 new services were connected with the Company's system—making a total of 200,097. The Company's works have been maintained, it is said, in "full and efficient repair out of revenue."

SUGGESTED IMPROVED LIGHTING OF HYDE PARK.

The "Sanitary Record and Municipal Engineering" has lately been criticizing the public lighting in the immediate vicinity of the Houses of Parliament and Westminster Abbey, which is under the control of the Office of Works. In a recent issue, it was recognized that the officials in this department had been roused out of their lethargy, and that improvements had been effected, by the alteration of a number of gas-lamps from the ordinary to the inverted system, whereby there is a fourfold increase in illuminating power with a saving of about 20 per cent. in gas and reduced cost of maintenance. Our contemporary suggests that there are other examples of bad lighting under the care of the Office of Works which would well repay a little attention; and the present "antiquated lighting" of Hyde Park is cited as an instance. We give below the remarks made upon this subject.

The main drives and entrances are lighted by means of square lanterns, such as are commonly used for street lighting, fitted with from two to five upright incandescent gas-burners. These will consume from 10 to 25 cubic feet of gas per hour, and the candle power produced will be from 150 to 250. The walks are lighted by means of spherical lanterns on columns about 10 feet high, staggered on either side of the path at a distance of 25 yards apart. These are fitted with one upright burner, consuming 5 cubic feet of gas per hour, and giving about 70-candle power. The upper half of the lanterns is of opal glass. The majority of the lamps in the park are of the latter pattern. All the lamps are fitted with old upright burners, which should be replaced by those of the inverted type. [As illustrating the effect of substituting inverted for upright burners, a diagram is given showing that the light would be increased some four-fold without entailing any greater consumption of gas.] There is also the æsthetic aspect to be borne in mind in this case. Something must be sacrificed to make the park more or less beautiful by night. With this end in view, we suggest that, as the entrance and main drives must be well lighted, on account of the traffic, high-pressure lamps would be effective in these positions. Lamps similar to those fixed in (say) Whitehall, but of lower candle power (500 and 1000 would be ample), would have a good appearance and improve the illumination. For the walks we would suggest that 200-candle power low-pressure burners should be fitted (these would have the same consumption as the existing burners), and that the whole lantern should be glazed with opal glass. This would involve some loss of light, but there would still be ample to provide good illumination; and the effect of the illuminated globes and soft diffused light would be pleasing to the eye.

MOTHERWELL GAS-WORKS PURCHASE.

The Award.

With reference to the paragraph in last week's "JOURNAL" on the Motherwell purchase, the exact figures are now to hand. It is stated that the finding fixes the purchase price of the entire undertaking at £135,987, which is equivalent to about £2 8s. per share. The sum claimed by the Company was £234,514.

LIGHTING AND HEATING OF SHOPS.

Mr. Matt. Dunn, the Assistant-Manager of the Stockton Corporation Gas-Works, has given the continuation of his interesting lecture upon the "Lighting, Heating, and Ventilation of Shops" to the local traders. He described the construction of several modern gas-burners adaptable for shop lighting, and strongly recommended burners of the best quality, fitted with both gas and air adjusters, to permit of more perfect control and manipulation by persons of average intelligence. He showed also that defective and ineffective lighting was by this method done away with, and both satisfactory and economical results were obtained. For large business premises, he said, both exterior and interior, high-pressure gas lighting was by far the cheapest and most powerful system. Referring to ventilating cluster-lamps fixed close to the ceilings of shops, and equipped with flue-pipes, he pointed out that this form of illumination served the double purpose of lighting and of drawing away all products of combustion emitted from the burners, or any other form of objectionable ingredient mixed with the air.

The lecturer proceeded to demonstrate, by means of suitable apparatus, the utility and effectiveness of gas for the purpose of ventilation; and he proved that, as soon as gas was lighted in premises, fresh-air currents were induced, and so the air in the room was constantly being changed and revivified. Therefore, not only were the products of combustion removed, but, what was more important, the exhalations of people in the room were carried away as well. The ventilating activity of the gas-burner, he added, was one of its most valuable recommendations; and the testimony of scientific authorities proved conclusively that the alleged contamination of air by the products of the combustion of gas, and the repeatedly quoted statement: "The use of gas is injurious to health," were absolutely unfounded, and the result of biassed observations.

Mr. Dunn subsequently went on to compare the qualities of gas and electric light, and then dealt with the heating of shops, advising that radiant heat should at all times be aimed at, as it did not dry or detrimentally affect the atmosphere.

LURGAN ELECTRIC LIGHTING SCHEME.

Board of Trade Inquiry.

On March 30, and following days, Mr. G. B. Deane, Board of Trade Inspector, held an inquiry at Lurgan into an application by the Urban District Council for a Provisional Order authorizing the expenditure of £12,000 on the promoting of a municipal electric lighting scheme. Opposition was offered by certain ratepayers and by the Lurgan Gas and Chemical Company.

For the promoters, Mr. D. M. Wilson, K.C., said the inhabitants had become dissatisfied with the quality of gas supplied and with the price charged—especially having regard to the fact that the consumption was increasing, the population having grown during the last decade—while a number of people engaged in small industries wanted an electric power supply. The Council thought they could not give leave for private individuals to instal electricity; but when the Council agreed to recommend that steps should be taken on their own behalf, Mr. Pleasance, of the firm of Woodside and Co., of Belfast and Dublin, drew up a scheme involving a capital expenditure of £11,338, with revenue £2150, or, allowing for management, £1389 net. Calculating the ample margin of 7 per cent. for interest and sinking fund on £16,000, they had left a surplus of £269. Mr. Bloxam, the Chief Electrical Engineer to the Belfast Corporation, recommended a scheme that was slightly different from that of Mr. Pleasance, inviting a capital expenditure of £11,980, with a gross revenue of £1963, which, after deducting £1599 for expenses, left a net surplus of £364. The latter scheme was adopted. The Council had objected to a Bill for electric supply which was being promoted by the Gas Company, as it was only a counter-move to endeavour to maintain a monopoly of the lighting of the town.

Mr. F. W. Pollock, Town Clerk, gave particulars of amounts paid for gas in recent years, and said that, notwithstanding the introduction of governors, the value of the gas consumed last year had exceeded that of the previous year by £66. He denied that the purpose of the Council's Order being sought was to force the Gas Company to sell their works at a smaller price than could otherwise be obtained.

Mr. Walter Pleasance said his original scheme provided for the substitution of 80 gas-lamps by electricity, and his second scheme for the substitution of 140. He estimated the revenue from public lighting at £255; and the revenue from lighting the Council offices, &c. (now costing £86) at £60. He believed that £1260 would be obtainable from private consumers, charging at the rate of 6d. per unit, and that £525 would be received for power at 1½d. per unit. Lurgan contained many small factories, for which witness thought electricity would be cheaper and more convenient than gas. The cost of production he estimated at 2·48d.; and he calculated that 154,000 units would be sold per annum. His experience was that electricity at 6d. per unit compared favourably with gas at 1s. 8d. or 2s. per 1000 cubic feet. He had calculated that 84,000 units would be used in Lurgan for power, which meant that six factories would take on an average 14,000 units. He admitted, how-

ever, that he had never known a case where a small factory would take this quantity.

Mr. Percy Spalding, the Manager of the Dundalk electric station, said the profit on the Dundalk scheme for the first ten months was £1224; and after allowing £1386 for interest and sinking fund, there remained a net deficit of £162. For the year ended on March 31 last, the income showed an increase over the previous year of £1368, or 54 per cent.; and the gross profits were £1699. Allowing for interest and sinking fund, he believed the income and expenditure would about balance each other. The amount borrowed for the Dundalk scheme was £24,975.

Mr. T. W. Bloxam said that, apart from the supply of current to factories, he was convinced Lurgan would derive a revenue under the scheme from the introduction of electric-driven motor-cars, which would supersede those now driven by petrol. Notwithstanding that the price of gas in Belfast was only 1s. 9½d., per 1000 cubic feet, there was great difficulty in providing sufficient plant to supply electricity. His (witness's) amended scheme provided for 2½ miles of underground and 2½ miles of overhead cables. A surplus of £364 could be reasonably looked forward to. He believed there were people in Belfast under a £25 valuation who used electricity. Only 60 of the public lamps in Belfast were lighted by electricity; and the receipts from this source were £481, which worked out at 1·61d. per unit. The price he had fixed for public lighting in Lurgan was 4d. per unit; but the light would be of different quality.

In reply to Mr. R. Best. K.C., for the Gas Company, Mr. Bloxam said he would not be disposed to say electricity was pushing the life out of gas; but it was making it "buck up."

The inquiry was then adjourned until to-day (Tuesday).

EXAMINATIONS IN "GAS ENGINEERING."

The Polytechnic Question Papers.

We give below the questions set before the candidates in the examinations on the above subject held last week at the Regent Street Polytechnic, the classes at which are conducted by Mr. Alwyne Meade, Assoc.M.Inst.C.E. In both grades the candidates were directed not to attempt more than six of the eight questions set.

HONOURS GRADE.

1. Define what is meant by "calorific intensity." Assuming that calorific power will be the recognized standard of the future, give reasons for and against the value of the gas being judged on the net basis. Describe briefly what you understand by a "total heat calorimeter."

2. Sketch in detail some form of "anti-dip" as used with horizontal retorts, and state what benefits you would expect to follow the introduction of such a device.

3. Set out in tabular form the approximate cost into holder of both coal gas and carburetted water gas for a works having an output of (say) 3 million cubic feet per day. You may take 14s. as the cost of coal into store, and 3½d. per gallon for oil. Detailed expenditure in each case is required.

4. You are in charge of a works making 200,000 cubic feet of gas per day. One exhauster is dealing with this gas; but, owing to the seizure of a bearing, it suddenly pulls up. State in detail the exact steps you would take in order to deal with the breakdown, and how you would endeavour to prevent undue pressure from being thrown upon any portion of the apparatus. Describe any "safety" devices which could be brought into play on such an occasion.

5. Discuss the relative importance of the following characteristics of gas in their relation to present-day requirements: (*a*) specific gravity, (*b*) flame temperature, (*c*) flame volume, (*d*) calorific and illuminating power.

6. Recent experiments have shown the possibility of converting into ammonia the hydrocyanic acid resulting from the distillation of coal. State briefly your views as to the lines on which such transformation could be arranged for, and the probable effect on the total ammonia yield. Give figures to illustrate the likely advantages from the financial point of view.

7. Discuss the "direct" recovery of sulphate of ammonia, and give reasons for and against its general adoption on gas-works in preference to the prevailing process. Give a brief account of the Koppers direct plant.

8. Describe briefly three methods of governing gas-engines, and set down the advantages and disadvantages attached to each of the methods.

ORDINARY GRADE.

1. Recent experiments have shown that over 15,000 cubic feet of gas can be obtained from a ton of Durham coal. Consider a normal yield of (say) 12,000 cubic feet per ton, and write down the probable number of cubic feet of each constituent which would be obtained. Do the same for the 15,000 cubic feet yield, and show which constituents would be likely to account for the additional 3000 cubic feet.

2. Give sketches showing three methods of attaching a mouthpiece to a fire-clay retort. Point out the merits and defects of each method.

3. Give a brief outline of any two systems of vertical retorts. The distinctive features of the systems should be mentioned, and figures given (such as size and length of retorts, coal carbonized per diem, &c.) to illustrate the difference between them.

4. State what precautions you would take when emptying or refilling a purifier. Discuss the effect of adding air to the gas during purification. Give the permissible quantity of the latter, and the likely consequences if this quantity is exceeded.

5. Sketch diagrammatically a water-gas generator, showing the reactions which take place during the "run" and "blow." State what

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you understand by an "up" and a "down" run, and show clearly in your sketch the pipe arrangement necessary for carrying this out.

6. Distinguish between: (*a*) saturated hydrocarbons and unsaturated hydrocarbons, (*b*) benzene and benzine, (*c*) gross and net calorific power, (*d*) "free" and "fixed" ammonia, (*e*) B.H.P. and I.H.P.

7. Enumerate the tests you would apply to a sample of coal before purchasing the same for gas making. State which is, in your opinion, the most important test. Assuming a works can obtain coal for 14s. per ton delivered, show what proportion of this expenditure you would expect to recover by the sale of (*a*) coke, (*b*) tar, (*c*) sulphate of ammonia.

8. If you are looking through a number of complete specifications for a new retort-bench, state clearly the points which would receive your first attention in enabling you to judge as to the merits of each design.

LINCOLN WATER SUPPLY.

Grant to the Engineer for the Elkesley Works.

Substantial recognition of the services of Mr. Neil M'K. Barron, M.Inst.C.E., the Engineer of the new water scheme for Lincoln, was forthcoming at the last meeting of the City Council, when it was decided to pay him £1000 for his work in connection with the designing and construction of the new works at Elkesley. The resolution embodying the Committee's recommendation in the matter was not, however, allowed to pass without objection. It was mentioned by Mr. F. H. Livens, who seconded the adoption of the Committee's report, that it was arranged that Mr. Barron's salary should be £500 per annum so long as he remained in Lincoln. The works had entailed an expenditure of £227,000; and had the responsibility been entrusted to a consulting engineer outside the Corporation, 5 per cent. would have had to be paid on this sum, and, in addition, from 1½ to 1¾ per cent. on the quantities, which would have amounted to £15,322. At the very lowest estimate, the Corporation had been saved an expenditure of £10,000; and there was nothing to preclude a fitting recognition of the extra service their Engineer had rendered. If he resigned, as he had intimated in a letter to the Committee that he proposed to do, it was believed the city would be able to obtain the services of a man capable of efficiently discharging the administrative work of the water undertaking at a probable saving of £150 a year. It was proposed by Mr. J. Mills that the paragraph in the report regarding the suggested payment should be deleted. He contended that the Council had no authority to make the payment; and if it was done he hoped the Local Government Board would surcharge every member of the Council who voted for the resolution. Mr. C. H. Newsum, however, strongly supported the proposal; and the Committee's recommendation was then put and adopted.

ALTRINCHAM WATER SUPPLY.

The Sale of the North Cheshire Company.

The North Cheshire Water Company, whose undertaking the Manchester City Council last week decided to acquire for £138,400, supply water to an important residential portion of Manchester. The Company was formed in 1858; and they have always been dependent upon the Manchester Corporation for water—drawing upon the city reservoirs, and selling the water at a profit.

By an agreement entered into in 1864, the city arranged to supply half-a-million gallons of water daily for domestic purposes; and for some years this quantity was sufficient. But as the area developed, and the population increased, a larger supply was required. The Corporation agreed to give it, at a higher price, and on the condition that the arrangement might be terminated by the Corporation by a twelve months' notice. During the last few years, the Company have drawn 1½ million gallons a day; but when they asked for an agreement by which the district might be assured of an adequate supply for all time, it was refused, the Corporation making it quite clear that, as their own supply was limited, they could not give any further guarantees. This factor prevented the Company from carrying out a scheme for raising further capital, and compelled them to face the fact that they could not hope successfully to meet public needs. Negotiations for the sale of the undertaking followed; and the price mentioned was agreed upon.

"The loans and share capital are," says the "Manchester Evening News," to be paid off by the Company out of the purchase price, and, from a financial view, the shareholders do not come out of the affair badly." Every holder of a £10 share on which the Company have paid 10 per cent. is to receive £20; while each holder of a £10 share on which the dividend has been limited to 7 per cent. is to be paid £14. No compensation of any kind is to be paid by the Corporation either to the Directors or to the officials. The staff is to be retained; and the business will be conducted from the Altrincham office as in the past. The city authority for the next fifteen years will be bound to maintain the present income of the Company, in order to provide for the payment of interest and the repayment of the loan; but at the end of this time the charges will be lowered, it is expected, so as to correspond with Manchester rates.

NOTTINGHAM AND THE DERWENT WATER SUPPLY.

Action of the Water on Pipes—Supply Temporarily Discontinued.

In comparison with recent serious developments, previous complaints which had been heard in Nottingham as to the new source of water supply from the Derwent Valley sink into insignificance. The Corporation, at their meeting on Monday of last week, determined to

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discontinue, for the present at any rate, further utilization of the water. The burden of the dissatisfaction was represented originally by its doubtful potable qualities; but now another and more formidable factor has arisen. The report of the Water Committee disclosed that their attention had been drawn to the effect of the water on wrought-iron piping; the result of their investigations and the report of the Analyst pointing to the fact that if the supply were continued the whole of the wrought-iron pipes, cylinders, and boilers at present in domestic use in connection with hot-water supplies would quickly become choked, and would have to be replaced by lead or copper piping and fittings. The Committee felt, however, that they could not undertake the responsibility of casting this obligation upon the citizens without reference to the Council; and the supply of Derwent water had therefore been discontinued. They asked the Council to confirm their action, or, in the alternative, to authorize them to continue the supply of the water, and to make such new regulations as might be necessary in order to meet the altered conditions.

Mr. ATKEY, the Chairman of the Committee, in moving the adoption of the report, said the investigations had placed the Committee in a position of very grave responsibility and difficulty. They had previously entertained a feeling of considerable optimism regarding the Derwent Valley water, because it appeared that a much more abundant supply could be obtained from the scheme than had been previously expected. Unfortunately, however, during the last month or so the Committee's attention had been directed very forcibly by one or two citizens to the action of the water upon iron piping. It appeared inevitable that, if the Derwent Valley supply were continued, every iron pipe in the city would have to be replaced, either now or in the course of a few months, by pipes of lead or copper, or some other metal which was not acted upon. This would have involved the city in very great expense; and the Committee felt that the responsibility of such action ought to be thrown upon the broader shoulders of the Corporation. The report embodied a plain statement of fact. The Derwent supply had either to be continued with the obligations mentioned in the report, or they had to turn it off. As its discontinuance would involve withdrawal from a very costly scheme, they felt they ought to have the approval of the Council before resorting to such a serious step. The proposal was to discontinue the supply for the present, in order that it might be ascertained whether the Derwent Valley Water Board could suggest any treatment of the water which would obviate the action upon the pipes referred to, and to give the ratepayers the opportunity of considering the whole matter.

Mr. E. HUNTSMAN seconded the motion.

Alderman S. COOK asked whether similar complaints had been made by the other towns participating in the Derwent scheme. It might be possible for the water to be filtered, or treated in some way chemically, so as to make it serviceable.

Alderman Sir JOHN TURNER thought the Council agreed that the Committee had, for the present, acted wisely to discontinue the supply. The Council's obligations in relation to the undertaking amounted to £25,000 a year. They knew what they had done when they had paid this; but they did not know what they would be doing if they continued the supply. He suggested that more information should be obtained in regard to the matter, and that then would be the proper time to discuss it in full.

Mr. E. RICHARDS thought that fuller information should have been obtained by the Committee before presenting their report. It would, he said, be interesting to know what had been the experience in the matter of Leicester, Derby, and Sheffield.

Alderman RADFORD proposed, as an amendment, that the matter should be deferred for a month, in order that more information might be obtained. He pointed out that water similar to that supplied from the Derwent Valley was used in other large cities and towns. Liverpool and Glasgow, for example, used water drawn from the moorlands, and there might be some useful information available as to its special treatment.

Mr. E. HARLOW seconded the amendment.

Alderman A. BALL said surely it would be possible to treat the Derwent water so as to eliminate its dangerous qualities. From every point of view, the matter was a most serious one. He would like to know how they would be fixed for a supply if water from the Derwent Valley was shut off.

Alderman Sir J. T. M'CRAITH said, so far as health was concerned, investigation had demonstrated that the Derwent water was absolutely pure and harmless.

In replying upon the discussion, Mr. ATKEY said it was intended by the Water Committee to do exactly what was suggested by the amendment. He very much doubted, however, whether they could do it in a month. The Committee were faced with the responsibility of either taking up the pipes or turning off the water; and, in regard to either of these courses, they felt they must have the backing of the Council. From the point of view of public health, the Derwent water was absolutely pure—he might almost say ideal, except, perhaps, for its tint. It was only within the last month that specific complaints had been received as to its action upon the iron pipes; and the Committee had taken every possible means of investigating the matter. Sheffield experienced this pipe trouble thirty years ago, and substituted leaden for iron pipes. Leicester and Derby used galvanized iron, and the effect had not yet been felt in these towns, although he feared it would be felt before long.

The amendment was defeated; the Committee's report being adopted by a large majority.

Effect in Neighbouring Towns.

Since the matter was brought before the Nottingham City Council on Monday, the possible effect of the supply in relation to the neighbouring towns concerned in the Derwent scheme has been assiduously discussed. While the position of Sheffield seems to be the most secure, there appears no present cause for alarm either at Leicester or at Derby. In Sheffield the authorities have for long taken great care to ensure that no wrought-iron pipes are used, such as are allowed at

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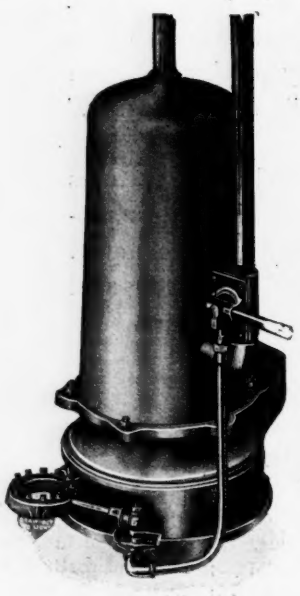

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Nottingham. All the service-pipes are of lead; while the street mains are of cast iron. For domestic and other uses, Sheffield now take from the Derwent supply one-fifth of the total consumption of water in the city. It is Leicester which is by far the largest partner in the Derwent undertaking; and the authorities in the town view the situation with comparative equanimity. Mr. Gerald T. Edwards, the Engineer and Manager of the Corporation Water Department, declared last Tuesday that there is no cause for alarm so far as they are concerned. No complaints had been received, and none were anticipated. Nottingham's trouble, Mr. Edwards suggested, was probably increased by the circumstance that pure Derwent water was used; whereas in Leicester they mixed the supply with a harder water, which gave them in the summer about 5 degrees of hardness more than the Nottingham water. The only complaints received had been in respect of the colour of the water; and these came in soon after the new supply was turned on. They had had none since; and apparently everything was quite satisfactory. With regard to Derby, no undue corrosion has yet been observed in connection with the galvanized pipes used there, and none is anticipated. Derby's proportion of the Derwent water is mixed with the harder water from the old works at Little Eaton; and therein apparently may be found the reason for the immunity.

LONDONDERRY WATER SUPPLY.

Irish Local Government Board and "A Makeshift Scheme."

At a Meeting of the Water Committee of the Londonderry Corporation last Tuesday, a letter was read from the Local Government Board for Ireland referring to an inquiry held by their Chief Engineering Inspector (Mr. P. C. Cowan) into the Corporation's petition for a Provisional Order to enable them to acquire lands needed for an auxiliary water supply for the city. The Board stated that they were satisfied the evidence did not show that the Corporation's scheme was a proper one. It was clear that an urgent need existed for obtaining a pure and adequate supply of water which would meet the city's requirements at all seasons; and the anticipated increase in the population must also be taken into account. They, accordingly, did not consider that it was in the interest of the ratepayers to sanction a makeshift scheme such as that contemplated, and they were not prepared to grant the petition. They trusted the Corporation would now press forward a comprehensive scheme for the permanent improvement of the supply.

Alderman Anderson (the Chairman of the Committee) suggested that they should reply that (as the decision rendered it impossible for the Corporation to provide a proper stand by scheme such as that proposed, in case of an emergency arising during the time that must elapse until a permanent scheme could be provided), in the event of a disaster overtaking the city by reason of water shortage, the responsibility must rest with the Local Government Board. This was agreed to.

NOTES FROM SCOTLAND.

From Our Own Correspondents.

Saturday.

The annual dinner of the Edinburgh and Leith Corporations' Gas Commissioners took place on Monday. On this occasion it was held in the Commissioners' own offices. Consequently the number attending was considerably reduced—in fact, only about 45 were present; and these consisted principally of magistrates, town councillors, and officials of the two Corporations. The Lord Provost, who was in the chair, claimed that the dinner was a means of advertising their business, and said it was their duty to proclaim from the housetops what they were doing, not only in the way of producing a grand illuminating power, but also an excellent heating and cooking power. The question of the amalgamation of the city and the burgh was frequently referred to, and he thought the key to amalgamation was common sense. The Town Clerk of Leith, in proposing the toast of the "Gas Commissioners," said that during the twenty-five years they had been in charge the output of gas had increased by about 75 per cent.; and all their figures, except the price of gas, had gone up. Bailie Lindsay, the Convener of the Works Committee, referred to the increase in the sale of gas since gas-cookers had been supplied rent free and the gas-fires hired out at low rentals. This was started in 1912; the increase equalling 4 per cent. in 1913. This year it was expected that there would be at least 3½ per cent. increase. They had not been able to reduce the price of gas, as they were paying 2s. 6d. a ton more for coal, residuals had fallen, and wages had gone up to the extent of £4000; but they had given other concessions. They had fixed 900 gas appliances in 1912-13, and in 1913-14 nearly 11,000. By applying sinking fund, loan repayment, and interest to the redemption of capital £353,377 had been so redeemed. Councillor Stewart proposed the toast of "The Officials," and said that the Commissioners realized the whole-hearted manner in which the work was done in the two departments presided over by Mr. Masterton and Mr. Canning Williams. Mr. Masterton, the Engineer and Manager, in replying, modestly gave credit for the success to the Commissioners and other officials.

The new Woodall-Duckham vertical retort-house for the Greenock Corporation Gas-Works at Inchgreen, is to be erected on a site where the nature of the subsoil is very uncertain. It was therefore necessary in places to fill in with mass concrete before the steel for the reinforced concrete raft, which it has been decided to use, was put down. This raft is of the slab type, made up of 6 beams 2 ft. 3 inches deep over all, and filled in with 16-inch slabs. The total area is just over 5500 superficial feet; and the raft will have to carry an average load of about 15 cwt. per square foot. The centre four beams will carry the 40 vertical retorts; while the outside beams will carry the walls. The design for this raft was prepared by the Indented Bar and Concrete Engineering Company, Limited. At the Dean of Guild Court the plans have been passed for the gasholder to be erected at the Inchgreen works.

The statement of the Manager of the Fraserburgh Council Gas-

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Works, Mr. M. D. Campbell, shows a very gratifying increase—no less than 3,561,000 cubic feet—on a previous annual consumption of 28,243,000 cubic feet. It was intimated that the alterations and extensions at the Broad Street Gas-Works site had been commenced. It is suggested that consumers of gas through slot meters should receive receipts for all money paid by them. It is difficult to understand why this should be necessary, as if it is a question of the amount of money that has been spent upon the gas being known to the consumer, he or she can easily be present at the opening of the cash-box, and so see for themselves. If, on the other hand, it is to be done as a check on the collector, there is more to be said in its favour.

The result of the examinations in the "Gas Manufacture" class carried on by Mr. Henry O'Connor, Assoc.M.Inst.C.E., at the Heriot Watt College, shows that Mr. R. W. Simpson takes the prize; and Messrs. A. Thomson (92 per cent.), H. Doran (85), Cuthbert Hamilton (75), A. J. Doran (70), D. D. Bruce (65), J. Henderson (64), D. Morton (58), and W. Grieve (50) obtained certificates. In the "Gas Supply" class, held at the same college, Mr. David H. Wilson (92 per cent.), took the prize; while Messrs. Samuel McKail (90), Gregory Cairns (74), William H. Black (72), Alex. Haldane (69), John Cowe (59), and Henry H. Shutze obtained certificates.

At the Royal Technical College, Glasgow, Mr. J. S. M'Nicol takes the first prize; and Messrs. A. Sutherland (81 per cent.), J. Jamieson (80), T. Orr (73), H. M'Vean (70), M. Littlejohn (61), G. Carr (61), W. Young (60), and J. W. Hall (60) get certificates. In the "Distribution" class, Mr. Malcolm Littlejohn took the first prize (95 per cent.); and the following obtained certificates: Messrs. James Jamieson (86), Robert Reid (85), Thomas Orr (83), James Graham (82), Alex. B. Munro (81), William Hogg (80), J. W. Scott (80), James W. Beveridge (80), Archibald Wyllie (76), Geo. Donaldson (72), Alex. Campbell (71), Geo. Carr (68), William Young (67), William Flaherty (62), William Blair (62), and Peter Abercrombie (60).

As already mentioned in these "Notes," the village of Aberdour is to have a supply of gas which will be taken from the Cowdenbeath Gas Company; and the Dunfermline District Committee have agreed to the proposal. The supply is to be on the same terms as those existing in Cowdenbeath itself; while the agreement with the district Committee is to last for a period of ten years. It is a curious fact that Cowdenbeath, which is 6 miles away, is prepared to supply gas in Aberdour at a cheaper rate than Burntisland, which is only 2¾ miles away, despite the fact that the cost of the main will probably be something like £3500, as against £1600 if supplied from Burntisland.

Gas for Strabane Workhouse.—A meeting of the Strabane (co. Tyrone) Board of Guardians resolved to ask the Gas Committee of the Urban District Council to undertake the work of installing gas in the workhouse. The Guardians themselves were unable to get a contractor to do it for less than £107, whereas the Council's estimate (for 103 lights) was £101.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

Pitch is looked upon as firmer, and may be called 38s. to 38s. 6d. per ton net. The prices of other products remain as reported last week.

There is more inquiry for sulphate of ammonia. It is understood that for 25 per cent. quality £11 15s. has been paid; and makers are now asking £11 17s. 6d. per ton, net and naked, at makers' works.

Tar and Tar Products in the Provinces.

The average values during the week were: Tar, 25s. 9d. to 29s. 6d. Pitch, east coast, 37s. to 37s. 3d.; west coast, Manchester, 36s. to 36s. 3d.; Liverpool, 36s. 6d. to 37s.; Clyde, 36s. 3d. to 36s. 6d. Benzol, 90 per cent., naked, North, 10¼d. to 10½d.; 50-90 per cent., naked, North, 10d. to 10⅛d. Toluol, naked, North, 10½d. to 11d. Crude naphtha, in bulk, North, 4⅜d. to 5¼d. Solvent naphtha, naked, North, 9¼d. to 9⅜d. f.o.b. Heavy naphtha, naked, North, 9d. to 9½d. f.o.b. Creosote, in bulk, North, 3⅛d. to 3¼d. Heavy oils, in bulk, 3⅛d. to 4d. Carbolic acid, casks included, 60 per cent., prompt, east and west coasts, 1s. 0½d. to 1s. 1d. Naphthalene, £4 10s. to £10; salts, 55s. to 60s., bags included. Anthracene, "A" quality, 1½d. to 1⅝d.; "B." nominally ¾d. per unit, packages included and delivered.

Sulphate of Ammonia Prices in the Provinces.

LIVERPOOL, *April* 9.

In consequence of the colliers' strike in Yorkshire, the market for this article has taken a distinct turn for the better since the commencement of the week, and values have advanced to some extent at all the ports for early shipment. The quotations to-day are £12 5s. per ton f.o.b. Hull, £12 7s. 6d. per ton f.o.b. Liverpool, and £12 7s. 6d. per ton f.o.b. Leith. There is no change, however, in the forward position, and producers are still willing to accept £12 per ton f.o.b. principal ports for July-December delivery; but buyers do not show much keenness to operate at this figure.

Nitrate of Soda.

The tone of this market is easier, and spot prices have been reduced to 10s. 4½d. per cwt. for ordinary, and 10s. 7½d. for refined quality.

From another source it is reported that the market for sulphate of ammonia has been decidedly quiet during the last few days; and it is said that lower prices have been accepted at several ports. Outside London, makes to-day are quoted at £11 10s.; Hull, £12 5s.; Liverpool, £12 6s. 3d.; Leith, £12 7s. 6d.; Middlesbrough, £12 5s.

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COAL TRADE REPORT.

Northern Coal Trade.

The Northern coal trade is irregular in price through the continued strike in Yorkshire, and the holiday restriction of the production. In the steam coal trade, there is not much fresh business doing, as collieries have little fuel for sale just at present. Best Northumbrian steams are about 14s. 6d. per ton f.o.b.; seconds are near 13s. 9d. per ton; and steam smalls are 8s. 6d. to 9s. 6d. Gas coals are in fair inquiry, though the home consumption is less. Best Durham gas coal is 14s. 6d. per ton f.o.b.; seconds about 14s. per ton; and "Wear specials from 14s. 6d. to 15s. These quotations, however, vary rapidly according to the position in the Yorkshire district. Among the contracts in the market, it is reported that one for the Western Union of France Gas-Works has been placed for some 50,000 tons of Durham gas coal, delivery over a year from June, at a price said to be near 13s. per ton f.o.b. It is also reported that prices for gas coals for Italy, in cargo-loads, have risen at Genoa since the strike in Yorkshire began, and that for best Durhams 22s. is now quoted at that port. Good gas coke is about 13s. 6d. to 13s. 9d. per ton f.o.b. in the Tyne; but values change with the prospect of duration of the difficulty in Yorkshire.

The Kingstown Lighting Schemes.

A report of the Kingstown Lighting Committee considered by the Urban District Council, stated that the Committee had no *locus standi* to appear before the Committee of the House of Commons to whom the Provisional Order Bill promoted by the Dublin and South-Eastern District Electric Supply Company was referred. The Committee recommended that the Bill be opposed as far as possible, and that a deputation be sent to London to enlist the co-operation of Irish members to this end; the Council having already declared that such undertakings should be in the hands of municipal authorities. The Council appointed a deputation.

Cancer and Coal.

In his book on the cancer problem, Mr. C. E. Green states that he found that, while cancer is almost unknown in some industries where persons work daily in lime, it occurs frequently among those brought into contact with sulphur fumes. Wherever chimneys abound, he discovered that cancer is prevalent; and where chimneys draw badly this prevalence is increased. As the result of many observations, the conclusion arrived at is that the lie of the ground and its association in the combustion of coal play an important part in determining the incidence of cancer. And, while cancer is extremely prevalent in districts where coal is burned, it is absent where the fuel is peat. The inference is drawn, says "The Times," that the combustion of a fuel rich in sulphur (in one district where special peat containing sulphur was used, cancer was found) is responsible for the prevalence of this disease. Further, it is contended that where the houses of the people are built on sloping sites or in hollows, the incidence is higher, owing to smoke accumulation. Where there is free draught, on the other hand, the incidence falls.

Concessions in China.

The Chinese Government, in connection with their negotiations for loans, have frequently made good "copy" for the newspapers, though investors may not always be able to enjoy the humour. A case in point is reported by the Pekin Correspondent of the "Daily Telegraph," who cables: "A formidable storm is brewing over the French industrial 150,000,000 franc loan. The prospectus gives investors to understand, though the language is curiously vague, that the bank undertakes not only the Pekin tramways, but all municipal works, in defiance of the charters already existing. Consequently, the Pekin Electric Lighting Company, who possess a 53 years' unexpired charter, is notifying the President that, unless the implication that its valuable rights are being transferred is withdrawn, Pekin will be plunged into darkness by the immediate cutting off of the power stations. Furthermore, the Pekin Water-Works Company are contemplating equally drastic action unless the meaning of the language of the loan prospectus is explained; while yet a third Chinese Company, who possess a charter for electric tramways, are determined to offer the bitterest opposition to the transfer of their rights."

Gas Matters at Devonport.

At the meeting of the Devonport Town Council last Thursday, Mr. M'Donald asked whether any change had been made in the pressure of the gas, and said consumers generally complained of increases in their meter-readings, amounting in some cases to as much as 50 per cent. The Town Clerk said the pressure had been increased owing to complaints of inadequate supply; but this would not affect the meter readings if the consumer regulated the supply at the main-cock on the inlet to the meter, or at the taps on the fittings. Nothing had been, or was being, done in the process of manufacture which would cause consumers to burn more gas. Mr. Weakford remarked that he had received more than eighty letters complaining of increased gas bills. Alderman Tozer (the Chairman of the Gas Committee) said it had been found on investigation that the fault rested in many cases with the gas-fittings. They were using the best coal for gas making, and could not understand how anything in the quality of the gas could account for the increased consumption. As the Town Clerk had explained, consumers could reduce the pressure for themselves by regulating the inlet to the meters; and members of the Council could point this out to those from whom they received complaints.

The Limerick Corporation have asked their Law Agent to report as to amalgamating the Gas and Electricity Departments.

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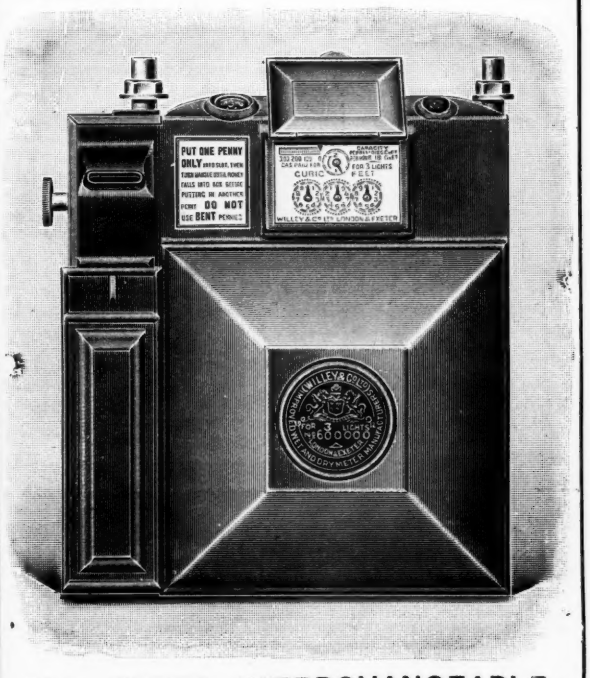

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Bermondsey Street Lighting.

The Electricity and Street Lighting Committee of the Bermondsey Borough Council, in their estimates for next year, have set aside the sum of £5000 for gas lighting in the streets and £6303 for electric lighting. When the estimates were considered by the Council, Alderman Stickland inquired when the charge for electric lighting for street purposes was to be reduced to the same price as was charged to private consumers, who were only called upon to pay 2d. per unit, as against 4d. charged to the Council. If the undertaking did not pay, they should raise the price to private consumers, and not call upon the Council to make up the deficiency. Mr. Gladwell Newell, the Chairman of the Committee, replied that he was at present unable to say when the charge for public lighting would be reduced. He hoped the Committee would at an early date be able to revise the charges. Alderman Storey said the prices for those using the electric light during the day should be increased, as the Council had put in extra machinery in order to cope with it. If this were done, the prices for public lighting could be at once reduced. The Council adopted the estimates.

Rochdale Gas Workers' Wages Advanced.—Recently an application was made for advances of wages and a week's holiday, with pay, for the stokers and labourers at the Rochdale Gas-Works. The matter has been under the consideration of the Works' Sub-Committee, and, on their recommendation, the full Committee decided at their last meeting to advance the wages of the labourers and coke-wheelers from 26s to 27s. per week. No advance was made in the wages of the stokers; and in view of the decision of the Council some two or three years ago on the subject of holidays with pay, this question was not reopened by the Committee.

Gas-Engines and the Coal Strike.—Writing at the beginning of last week on the subject of the Yorkshire coal strike, the Special Correspondent of "The Times" said: "In Sheffield, thanks to its proximity to the supplies from Derbyshire and Nottinghamshire, only some of the smaller works have had to put their men on short time, and in one or two cases to close. The hardware trade is protected by the almost universal use of gas and electric power. Many hundreds of small firms which produce cutlery, files, and springs use gas-engines. In 1912, they were able to work at full pressure throughout the strike; and the gas supply of the city, on which they depend, is now assured for an even longer period ahead."

A Company, entitled "Aitches Limited," was registered on the 3rd inst., with a capital of £500 in £1 shares, and offices in Great Titchfield Street, W.

The Nelson Town Council have approved a recommendation of the Water Committee that Mr. Percy Griffith be appointed to act on behalf of the Corporation, with full power to settle, with an engineer appointed by Messrs. Whyte and Co., Limited, all matters in dispute between the Corporation and the Company under the Ogden reservoir contract; and that in case of difference the points in dispute to be submitted to an umpire to be appointed by the engineers.

At the Old Street Police Court last Wednesday, Edward Lee was charged with stealing four gas-burners, two beaded-shades, some mantles, and two flash-lamps, together value 12s. 3d., the property of the Wholesale Fittings Company. Mr. Frederick Burnett, the Manager to the prosecutors, said prisoner had been in the firm's employ as lift man, &c., and had had access to the goods in question. Things had been missed for some time past. Prisoner, when questioned, admitted the theft, and said he had been "hard pushed" for money. A remand was ordered.

APPLICATIONS FOR LETTERS PATENT.

7992.—Stimson, E. F., "Gas ovens." March 30.
8023.—Bailey, E. G., "Liquid meters." March 30.
8030.—Johnson, J. Y., "Effecting the removal of carbon monoxide from gas mixtures." A communication from the Badische Anilin und Soda Fabrik. March 30.
8091.—Drakes Limited and Drake, J. W., "Charging retorts." March 31.
8096.—Milne, J., and James Milne and Son, Ltd., "Gas-meters." March 31.
8250.—Goldschmidt, E., "Gas lighting and regulating devices." April 1.
8366.—Barralet, J. H., and the Davis Gas-Stove Company, Ltd., "Geysers." April 2.
8386.—Krauss, F., "Combined burner for gas and oxygen." April 2.
8419.—Watkinson, J. G., and Fletcher, P. H., "Inverted burners." April 3.
8438.—Drakes Limited and Walker, A., "Discharging retorts." April 3.
8439.—Drakes Limited and Walker, A., "Screening coke or coal." April 3.
8465.—Crouch, R. J., "Gas flash-signs." April 3.
8476.—South Metropolitan Gas Company and Chandler, D., "Gas cooking-stoves." April 3.
8485.—Gerard, L. T., "Gas-burners." April 3.
8489.—Stephenson, J., "Manufacture of carburetted water gas." April 3.
8493.—Swan, E. & J., "Pendants." April 3.
8532.—Duckham, A. M'D., "Classifying coal or coke according to size." April 4.
8537.—New Liverpool Rubber Company, Ltd., and Carpenter, G., "Flexible tubing." April 4.
8540.—Adams, P. J., "Breaking coal." April 4.

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Lighting of Warrenpoint.—A distinct improvement in the lighting of Warrenpoint is hoped for as a result of the Gas Company's experiments with 300-candle power "Falcon" inverted street-lamps. One advantage claimed is that these lamps are storm-proof—an important consideration at a seaside resort.

Chorley and Vertical Retorts.—A Local Government Board inquiry has been held at Chorley, concerning an application by the Town Council for sanction to a loan of about £30,000 for gas-works purposes. Of this sum, more than one-half is for an installation of Glover-West vertical retorts. It was shown that the relation of the present demand to the producing capacity of the works is such as to render the early carrying out of the extensions a matter of necessity.

Brentford Gas Bill.—The Wandsworth Borough Council, at their meeting on Thursday last, were informed by the General Purposes Committee that nearly all the objections of the Council to the provisions of the Brentford Gas Bill had been met; but they recommended that, with the view of retaining the Council's *locus standi* with regard to one or two matters still outstanding, a petition against the Bill be sealed by the Council for presentation to the House of Commons. The Council adopted the Committee's recommendation.

Bolton and Darwen Water Arbitration.—Reference was made to the arbitration [the award in which was given on p. 58 of last week's "JOURNAL"] at a meeting of the Darwen Town Council, when Mr. W. P. Kay said the cost of the proceedings to the town, together with their share of the Bolton Act of 1905, was £2000. But, having regard to the fact that every 1d. per 1000 gallons represented £450 a year, he thought the expenditure was justified. Darwen had now a first claim on this particular water supply; and it would be ample for the needs of the borough for generations to come.

Gas Fatality at Pokesdown.—In a room at Pokesdown, near Bournemouth, a jet which had by some means got turned on, while the gas remained unlighted, was the cause of a sad fatality. Four children were in the room; and when the escape of gas was discovered one of them was dead and the other three were in an unconscious condition.

Neath Water Scheme Completed.—Water-works at Ystradfellte which the Neath Rural District Council have been constructing during the past seven years, were opened last Saturday week, when water was turned into the reservoir by Mr. A. T. Williams, J.P., the Chairman of the Council. The Mayor of Neath (Mr. W. B. Trick, J.P.) presented Mr. Williams with a silver salver, suitably inscribed, in appreciation of the services rendered by him as Chairman of the Water Committee during the last fifteen years. After an inspection of the works, the party were entertained at lunch by Mr. Williams. The total cost of the scheme has been £275,000; and the reservoir has a watershed of 20,000 acres, and a storage capacity of 700 million gallons.

The Bradford Show-Room.—Last Tuesday, the Bradford Corporation confirmed a resolution of the Gas Committee determining upon the opening of a show-room in Darley Street and the appointment of Mr. H. S. Pecker, of Northampton, as Manager. There was one adverse critic only—Alderman Gadie, who thought that it was undesirable to appear to be placing gas and electricity in competition. Councillor J. H. Palin, a chief among the Labour Party's representatives, approved unhesitatingly, on the ground that, by the reduction of coal combustion, the public health would be improved; and Alderman Deighton, the Deputy-Chairman of the Gas Committee, said there was certainly room for both electricity and gas in Bradford. With regard to cooking and heating, gas could do for the people what electricity could not do.

GAS COMPANIES IN THE STOCK EXCHANGE.

The week just concluded on the Stock Exchange was a brief but not unpleasant period of four working days. Thanks to a lull in the hurricane of home politics, where a little breathing space cannot come amiss to both parties, markets in general were calm and free from agitation. Some, indeed, of the lesser centres were quite cheerful, with active business and advanced prices. Consols were steady; closing practically unchanged at figures rather more closely drawn in. The weakest spot in the House was in Transatlantics—the old favourite both here and on Continental bourses. Canadian Pacifics were smartly thrown back by the adverse decision in regard to freight rates; and Americans were freely offered in Wall Street. The opening on Monday was very quiet, and preparations for the settlement exacted attention. Movements were slight and unimportant, and for the most part irregular; being at their liveliest in small markets. Government issues were fairly firm, and Consols were unchanged. Rails were sluggish, with a few small ups and downs. Foreign were steady. On Tuesday, the approach of the holidays was very apparent. Many markets were half-asleep. But Government issues were quite strong, and Consols advanced ¼ for money and ⅜ for the account. Rails and the rest were quiet and composed. Wednesday was a curious day; markets going all sorts of ways. Consols had quite a weak fit, and receded ⅛ for money and the account; but Rails were fairly strong and very animated. Transatlantics had their bad time, as previously mentioned. Oils were a merry little market. Thursday's business was, of course, at very low pressure, though the special lines which had lately been having an innings all to themselves still kept it going. Markets in general, however, were not downhearted; and all but Transatlantics may be said to have closed cheerful. Consols were unchanged at 76⅛ to 76⅜. In the Money Market, there was a good demand and an equally good supply. Discount rates stiffened and closed quite firm. Business in the Gas Market was about an average four days' work. The tone was excellent, and good prices were obtained all round. Some more quotations in the Suburban and Provincial group, which had long been standing at inadequate figures, were revised, and received their belated promotion. In Gas Light and Coke issues, the ordinary was in fair demand at rather harder figures, transactions ranging from 101½ to 102⅜—a rise of ½. In the secured issues, the only deal was one in the maximum at 77. South Metropolitan was quiet and unchanged at 109½ to 110½. In Commercials, the 4 per cent. changed hands at 106½ and 107½. Among the Suburban and Provincial group, British realized 44, and Wandsworth "C" 114½. In the Continental companies, Imperial marked 173 to 175, Union 82, ditto preference 119, and European 17⅞ to 18 5/16. Among the undertakings of the remoter world, Bombay was done at 6¼, Melbourne at 98½, Monte Video at 12, Ottoman at 7½ and 7 9/16, Primitiva at 6½ and 6⅝, and ditto preference 5 to 5⅛.

OFFICIAL QUOTATIONS AT THE CLOSE OF THE WEEK.

Bank Rate (fixed January 29), 3 per cent. Last year, 5 per cent. Consols, 76⅛—76⅜. Previous week, 76—76¼.

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
1,551,868	Stk.	April 8	2½	Alliance & Dublin Ord.	58—63*	+1½	3 19 4
374,000	,,	Jan. 15	4	Do. 4 p.c. Deb.	73—81	..	4 12 9
280,000	5	Oct. 15	7½	Bombay, Ltd.	6—6½	..	5 15 5
50,030	10	Feb. 16	16	Bourne- 10 p.c.	27⅞—28¾	..	5 11 4
382,500	10	,,	7	mouth Gas B 7 p.c.	14⅞—15	..	4 13 4
75,000	10	,,	6	and Water Pref. 6 p.c.	13½—14	..	4 5 9
380,000	Stk.	Feb. 26	14	Brentford Consolidated	258—263	..	5 6 5
330,000	,,	,,	11	Do. New	204—209	..	5 5 3
50,000	,,	,,	5	Do. 5 p.c. Pref.	109—111	..	4 10 1
206,250	,,	Dec. 11	4	Do. 4 p.c. Deb.	93—95	..	4 4 3
217,380	Stk.	Feb. 26	11	Brighton & Hove Orig.	205—211	+8	5 4 3
244,200	,,	,,	8	Do. A Ord. Stk.	152—157	+6	5 1 11
530,000	20	Mar. 26	12½	British	44—45	..	5 11 1
120,000	Stk.	Dec. 30	4	Do. 4 p.c. Deb. Stk.	90—92	..	4 7 0
245,771	Stk.	,,	4	Buenos Ayres 4 p.c. Deb.	89—91	..	4 7 11
100,000	10	—	—	Cape Town & Dis., Ltd.	1—2	..	—
100,000	10	—	—	Do. 4½ p.c. Pref.	2¼—4½	..	—
100,000	Stk.	Dec. 30	4½	Do. 4½ p.c. Deb. Stk.	73—78	..	5 15 5
157,150	Stk.	Feb. 26	5	Chester 5 p.c. Ord.	106½—107½	..	4 12 2
1,513,280	Stk.	Feb. 12	5/9/4	Commercial 4 p.c. Stk.	106—108	..	5 1 2
560,000	,,	,,	5⅛	Do. 3½ p.c. do.	103½—105½	..	5 1 1
475,000	,,	Dec. 11	8	Do. 3 p.c. Deb. Stk.	71—73	..	4 2 2
800,000	Stk.	,,	4½	Continental Union, Ltd.	80—83	..	5 8 5
200,000	,,	,,	7	Do. 7 p.c. Pref.	117—122	..	5 14 9
492,270	Stk.	—	6	Derby Con. Stk.	123—125	..	4 16 0
55,000	,,	—	4	Do. Deb. Stk.	102—104	..	3 16 11
1,002,180	10	Jan. 15	10	European, Ltd.	17⅛—18½	..	5 8 1
16,386,660	Stk.	Feb. 12	1/17/4	Gas 4 p.c. Ord.	101—103	+½	4 14 7
2,600,000	,,	,,	3½	Light 3½ p.c. max.	75—79	..	4 8 7
4,062,235	,,	,,	4	and 4 p.c. Con. Pref.	95—98	..	4 1 8
4,674,850	,,	Dec. 11	3	Coke 3 p.c. Con. Deb.	73—75	..	4 0 0
258,740	Stk.	Mar. 12	5	Hastings & St. L. 3½ p.c.	87—89	..	5 12 4
70,000	10	Oct. 15	11	Hongkong & China, Ltd.	16⅜—17½	..	6 7 6
131,000	Stk.	Mar. 12	7⅝	Ilford A and C	147—150	..	5 1 8
65,780	,,	,,	6½	Do. B	115—118	..	5 3 10
65,500	,,	Dec. 30	4	Do. 4 p.c. Deb.	89—91	..	4 7 11
4,940,000	Stk.	Nov. 13	9	Imperial Continental	172—177	..	5 1 8
1,235,000	Stk.	Feb. 12	3½	Do. 3½ p.c. Deb. Red.	83½—85½	..	4 1 10
200,242	Stk.	Mar. 12	6½	Lea Bridge Ord. 5 p.c.	119—121	..	5 7 6
561,000	Stk.	Feb. 26	10	Liverpool United A	211—213	..	4 13 11
718,100	,,	,,	7	Do. B	143—145	..	4 16 7
306,083	,,	Dec. 30	4	Do. Deb. Stk.	99—101	..	3 19 3
63,480	Stk.	Dec. 30	3	Maidstone 3 p.c. Deb.	65—67	..	4 9 7

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
75,000	5	Dec. 11	6	Malta & Mediterranean	4⅜—4⅞	..	6 3 1
250,000	100	April 1	4½	Melbourne Met. of 4½ p.c. Deb.	98—100	..	4 10 0
541,930	20	Nov. 27	4	Monte Video, Ltd.	11⅜—12½	..	6 10 8
1,775,892	Stk.	Feb. 26	4½	Newc'tle&G'tesh'd Con.	9⅜—10	..	4 10 0
529,705	Stk.	Dec. 30	2½	Do. 3½ p.c. Deb.	83½—84½	..	4 2 10
55,940	10	Feb. 26	7/14.0	North Middlesex 7 p.c.	12½—13½	..	5 14 1
300 000	Stk.	Nov. 27	8	Oriental, Ltd.	120—125	..	6 8 0
60,000	5	Mar. 26	10	Ottoman, Ltd.	7⅛—7⅞	+⅛	6 9 0
60,000	50	Feb. 25	13	Portsea, Island B	127—130	..	5 0 0
100,000	50	,,	12	Do. C	118—121	..	4 19 2
249,980	5	Oct. 15	8	Primitiva Ord.	6⅜—6¾	..	5 16 5
499,960	5	Dec. 30	5	,, 5 p.c. Pref.	5—5¼	..	4 15 8
521,600	100	Dec. 1	4	,, 4 p.c. Deb.	93—95	..	4 4 3
346,198	Stk.	Dec. 30	4	River Plate 4 p.c. Deb.	87—89	..	4 9 11
275,000	5	Sept. 26	12	San Paulo, Ltd.	—	..	—
150,000	10	April 8	6	Do. 6 p.c. Pref.	10⅜—11¼*	..	5 6 8
125,000	50	Jan. 2	5	Do. 5 p.c. Deb.	48—50	..	5 0 0
135,000	Stk.	Mar. 12	10	Sheffield A	222—224	..	4 9 3
209,984	,,	,,	10	Do. B	221—223	..	4 9 8
523,500	,,	,,	10	Do. C	221—223	..	4 9 8
90,000	10	Oct. 15	7½	South African	10⅛—11½	..	6 10 5
6,429,895	Stk.	Feb. 12	5/9/4	South Met., 4 p.c. Ord.	109—111	..	4 18 6
1,895,445	,,	Jan. 15	3	Do. 3 p.c. Deb.	73—75	..	4 0 0
209,820	Stk.	Feb. 26	8½	South Shields Con. Stk.	155—157	..	5 8 3
952,795	Stk.	Feb. 26	6	S'th Suburb'n Ord. 5 p.c.	114—116	..	5 3 5
60,000	,,	,,	5	Do. 5 p.c. Pref.	110—112	..	4 9 3
117,058	,,	Dec. 30	5	Do. 5 p.c. Deb. Stk.	113—115	..	4 6 11
594,740	Stk.	Nov. 13	5	Southampton Ord.	101—104	..	4 16 2
120,000	Stk.	Feb. 12	7⅜	Tottenham A 5 p.c.	195—198	..	5 6 10
543,940	,,	,,	5⅝	District B 3½ p.c.	115—117	..	5 0 5
149,470	,,	Dec. 30	4	4 p.c. Deb.	89—91	..	4 7 11
182,380	10	,,	5	Tuscan, Ltd.	5—6	..	8 6 8
149,900	10	Jan. 2	5	Do. 5 p.c. Deb. Red.	95—97	..	5 3 1
236,476	Stk.	Mar. 12	5	Tynemouth, 5 p.c. max.	108½—110½	..	4 10 6
				Wandsworth, Wimbledon, and Epsom—			
30,000	Stk.	Feb. 26	8⅜	Wandsworth A 5 p.c.	151—156	..	5 7 4
255,636	,,	,,	6¾	,, B 3½ p.c.	129—134	..	5 2 7
108,075	,,	,,	5/17/3	,, C 3½ p.c.	110—115	..	5 2 0
352,000	,,	,,	6½	Wimbledon 5 p.c.	117—122	+5	5 0 5
98,000	,,	,,	6⅝	Epsom 5 p.c.	121—126	+5	5 5 2
88,416	,,	Dec. 30	3	3 p.c. Deb. Stk.	71—73	..	4 2 2

Prices marked * are "Ex Div."

Last week the annual dinner given by the Directors to the office staff and heads of departments of the Richmond Gas Stove and Meter Company, Limited, was held at Warrington. Mr. H. M. Thornton presided, and was supported by Mr. J. A. Ransome and Mr. J. W. Slack. Members of the staff provided an excellently rendered vocal and instrumental programme. A very enjoyable evening concluded with a vote of thanks to the Directors, passed on the proposition of Mr. W. H. Tickell.

During the consideration of coal supply tenders by the Tipperary Board of Guardians, a member inquired whether there had been a reduction in coal consumption since the installation of electric light in the workhouse buildings; and, being informed that "the saving was very little," said it was a great shame, and a glaring outrage on the ratepayers, that they should have thrown away a couple of thousand pounds for cooking, heating, &c. Another member said those who had signed in favour of this expenditure were all equally to blame.

WANTED, FOR SALE, CONTRACTS, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Appointments, &c., Vacant.

MANAGER (GAS-FITTINGS WORKS). No. 5867.
WORKING MANAGER. Weedon Gas Company.
WORKING MANAGER. Dawlish Gas Company.
ASSISTANT SALESMAN AND STOREKEEPER. Ormskirk Gas Company.

Appointments, &c., Wanted.

LEADBURNER, &c. No. 5862.

Gas-Works Wanted.

"D. G.," c/o Scripps's Advertising Offices, 13, South Molton Street, W.

Meeting.

IMPERIAL CONTINENTAL GAS ASSOCIATION. 21, Austin Friars. May 5. 2.30 o'clock.

Sales of Stocks and Shares.

BOGNOR GASLIGHT COMPANY. London Mart. May 5.
CREDITON GAS COMPANY. Rougemont Hotel, Exeter. April 22.
CROYDON GAS COMPANY. London Mart. April 28.
DUNSTABLE GAS AND WATER COMPANY. London Mart. May 5.
FELIXSTOWE GASLIGHT COMPANY. London Mart. May 5.
GREAT YARMOUTH WATER COMPANY. London Mart. April 28.
NORTH MIDDLESEX GAS COMPANY. London Mart. May 5.
NORTHFLEET GAS COMPANY. London Mart. April 28.
SEVENOAKS GAS COMPANY. London Mart. April 21.
SEVENOAKS WATER COMPANY. By Tender. April 25.
SOUTH ESSEX WATER COMPANY. London Mart. April 21.
SOUTHEND WATER COMPANY. London Mart. April 21.
UNITED DISTRICT GAS COMPANY. London Mart. May 5.
WATFORD GAS COMPANY. London Mart. April 21.

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DARLINGTON GAS DEPARTMENT. Tenders by April 24.

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